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THE

POPULAR SCIENCE MONTHLY.

MAY, 1880.

CLIMATE AND COMPLEXION.*

By J. M. BUCHAN, M. A.

THERE is a great diversity of opinion as to the reason of the differences of complexion to be observed among mankind. Roughly speaking, the hue of the skin varies with the latitude, the fairer races having their homes at a distance from the equator; the darker, within or near the tropics. This fact would seem to point to the position of the sun with reference to those on whom he shines as the cause. But the question presents difficulties which this supposition does not aid us to solve.

At the same distance from the equator we find the fair Englishman, the yellow Mongol, and the copper-colored Indian. To the north of the white Russian and Finn live the swarthy Lapp and Samoyed. North of the Caucasus are dark-skinned Tartars, south of it fair-complexioned Circassians. The aborigines of America vary less in color than the natives of the Old World. None of them are as fair as the Swede, none as black as the negro of Congo, and those living in Brazil on the equator are not the darkest. There are blacker men in Australia and New Guinea than in Borneo and Sumatra, though these islands are on the equator and those are not. The Shillooks of the Upper Nile, who live about 10° north latitude, are blacker than the Monbuttoo who are six degrees farther south.

Many attempts have been made to explain these and similar facts. It has been asserted that mountaineers are fairer than lowlanders in the same latitude. This is generally the case, but there are some striking exceptions to the rule. The natives of the Mexican plateaus are as brown as those of the coast, and the Aymaras and Quichuas of

* This paper embodies the substance of a communication made to the Canadian Institute, Toronto, at a recent meeting.

the Peruvian Andes are darker than the Yuracaras of the forests to the east. The inhabitants of the Altai Mountains are yellow ; those of the plains of European Russia, at the same distance from the equator, white. According to Foissac, the blackness of the negro is a consequence of his vegetable diet, by which his blood is overloaded with carbon. But this theory, likewise, breaks down when submitted to the test of a comparison with the facts. The nomads of the Asiatic deserts, who live mainly on milk and flesh, are certainly not fairer than the grain-eating peasants whom they plunder ; and the Buddhists of China and Japan, whose religion prohibits the use of animal food, do not differ in color from their neighbors of other creeds. The influence of humidity has attracted the attention of some writers. Sir R. Schomburgk and M. d'Orbigny hold that it tends to lighten, Dr. Livingstone and others that it tends to darken, the hue. I shall state below my reasons for agreeing with the former.

Mr. Charles Darwin, Professor Huxley, M. Quatrefages, and others, think it probable that racial distinctions owe their origin to the selective operation of the prevailing diseases of particular climates. Assuming, what is amply supported by facts, that individuals slightly diverging in various directions from the type are constantly being produced, it is obvious that if a dark or a light complexion be correlated with power to resist a particular disease, or group of diseases, a white race may, by natural selection, be gradually developed from a colored one, or *vice versa*. M. Quatrefages has suggested that the malarial fevers of Africa have wrought this effect there, and that phthisis has been the agent in the north of Europe. It certainly is the case that the tropical regions of Africa are very unhealthy for whites, and that the negro dies out north of the parallel of 40° in both hemispheres ; but this does not show that both races might not be acclimatized by slow degrees without loss of color. In other words, no reason has been shown for thinking that it is to the complexion and not to some other racial peculiarity that the relative immunity from certain maladies is due. To connect the color with this immunity is the object of this paper.

I may say at the outset that I do not attach much importance to the direct influence of climatic conditions. It is, indeed, a matter of common observation that these produce considerable effects on the individual. Pruner, for example, states that he has noticed that "the European acclimated in Egypt acquires after some time a tawny skin, and in Abyssinia a bronzed skin ; he becomes pallid on the coast of Arabia, cachectic white in Syria, clear brown in the deserts of Arabia, and ruddy in the Syrian mountains."* But there is no proof that these cutaneous changes are inherited. If, however, it can be shown that a particular kind of skin is better than others for withstanding certain obvious weakening influences of a given climate, it stands to

* Waitz, "Anthropology."

reason that those members of a race whose skins vary in the direction of this type will in each generation have the best chance of surviving and begetting children, and that, by the continued increment of successive variations in the same direction, the skin and the climate will ultimately be brought into accord.

The skin consists of two layers: the inner, dense and fibrous, furnished with blood-vessels and nerves, called the dermis, or true skin; the outer, horny, nerveless, and bloodless, called the epidermis, cuticle, or scarf-skin. The cells which compose the latter originate in the *rete Malpighii*, its lowest part, are gradually forced outward by new cells, and finally exfoliate. In some of these epidermic cells a pigment is found which varies in different races, but always contains a yellow element. The hue of the skin does not depend on this coloring matter alone, but is a compound effect, resulting from the white of the dermis, the red of the blood in the minute vessels near the surface, the color and quantity of the pigment, and the thickness of the cuticle. Where the cuticle is thick, the color of the pigment will predominate over the other elements on account of the greater depth of pigment-cells. Where it is thin, and the coloring matter light, the tint of the skin will be much affected by any change in the supply of blood to the capillaries at the surface of the body. This is the reason why the whites alone can turn pale and blush.

Closely related to the pigment of the skin are the coloring matters of the eye and hair. Dark-skinned people usually have black eyes and hair; fair hair and blue eyes are seldom found except in conjunction with a fair skin; and the eyes and hair of albinoes, in whom the pigment of the skin is wanting, are likewise destitute of coloring matter. The pink hue of their eyes is due to minute blood-vessels, whose color is masked in ordinary organs by the pigment of the iris.

It is noteworthy that the coloring matters of the epidermis and iris serve a very important purpose: they protect the tender underlying parts from the injurious effects of too much heat and light. Albinoes everywhere find it necessary to protect their skins and eyes from the effects of the sun's rays. In warm countries they seldom go out except at night. There is this difference between them and other men, that long-continued exposure to the sun, which ordinarily develops a condition of the skin capable of resisting its rays, does not do so in their case. It may here be remarked that the deeper the shade of the pigment, the more rays will it reflect, and the more effective will it be as a protective agency. On the contrary, the lighter the shade, the more light and heat will it permit to enter the body.

As an excretory organ, it is the function of the skin to discharge water, carbonic acid, and urea—the first in large, the others in small quantities. Perspiration, or the excreting of water, with some saline matter in solution, is effected in two ways: In the first place, sudoriparous glands, imbedded in the true skin, secrete sweat from the blood.

This is conveyed to the air by minute ducts passing through the epidermis. It is obvious that, the blacker the pigment, the less light and heat will be transmitted to excite these glands into activity. In the second place, there is a continual transudation of sweat from the minute vessels of the surface of the body through the epidermis at every point. The thicker or the more oily the scarf-skin, the less will the amount of this transudation be. If it be both thick and oily, as in many dark races, the quantity transuded will be reduced to a minimum; if it be thin and not oily, as in the fairest members of the white race, transudation will be copious.

The amount of transuded sweat depends, however, not merely on the thinness of the cuticle, but also on the degree to which the air in contact with the body is saturated with moisture; for there is a limit to the quantity of vapor which the air can absorb. This limit varies with the temperature, warm air absorbing more than cold. Such being the nature of the skin, I now proceed to inquire what kind of it will best suit particular regions. For this purpose climates may be classified as—

I. Arctic.
II. Temperate humid.
III. Temperate dry.
IV. Tropical humid.
V. Tropical dry.

I. When the skin is exposed to great cold, perspiration by transudation is accelerated. The frosty air, raised many degrees in temperature by contact with the body, becomes very dry, and greedily drinks in its moisture. At the same time the body loses, not only the heat which the air carries off, but also that which is rendered latent by the evaporation of the sweat. As a protection against the injury which a too rapid loss of perspiration and heat may inflict in an arctic climate, a thick integument is desirable. On account of the obliquity of the sun's rays a dark pigment will be a disadvantage, because it will prevent the passage of light and heat. Some pigment will, however, be needed, as not even in northern regions can albinoes expose themselves to sunlight with comfort. The coloring matter, then, will be light; but, owing to the thickness of the cuticle, the general effect will be yellow.

II. By a humid temperate climate I mean one occurring in a temperate zone, in which the air constantly contains a large amount of moisture. Humidity does not to any considerable extent depend on the amount of the annual rainfall. The annual rainfall of London is twenty and one half inches, that of Toronto thirty inches; yet the air of the former place is incomparably more humid. Countries in which this climate is found are distinguished from others in the same latitude by the limited range of the thermometer. This is due partly to the fact that water can not be so rapidly heated as air, and partly to the

check which the presence of haze, mist, or cloud in the atmosphere puts upon radiation. A humid temperate climate is also warmer than others in the same latitude, for it owes its existence in every case to breezes from warm seas. Breezes from cold seas can not produce a true humid temperate climate, because when they strike the land in summer they will be raised in temperature and rendered dry.

In humid temperate climates, since the rays of the sun, falling obliquely through a moisture-laden atmosphere, lose much of their light and heat, a dark pigment is a disadvantage. The vapor-clogged air tends to prevent perspiration, therefore a thin epidermis is desirable. The combination of a thin epidermis with a light pigment will give a fair complexion.

III. By a dry temperate climate I mean one occurring in a temperate zone in which the atmosphere is usually dry. Countries in which this climate prevails are distinguished from others in the same latitude by the great range of the thermometer. Their summers are hot and their winters cold. As a protection against the greater heat and brightness of the sun, a darker pigment than that which serves the purpose in humid temperate regions is necessary. To prevent the too rapid withdrawal of the fluid contents of the capillaries by the dry air, a thick cuticle is required. The combination of a thick cuticle with the pigment suitable to the intensity of the sun's rays will produce various shades of yellow and brown.

IV. By a humid tropical climate I mean one occurring in or near the torrid zone, in which there is no dry season. In such a climate vegetation will be luxuriant all the year round, and man will live in the shade of dense forests, in a steaming and enervating atmosphere, whose temperature will be high, but will vary little. Though the rays of the sun will descend vertically upon him, yet their power will be diminished by the vapor contained in the air, and he will not need so dark a pigment to protect him as the inhabitants of other tropical regions. Add to this, that a thin epidermis will promote perspiration which the moisture-laden atmosphere tends to check, and we come to the conclusion that the natives of such countries will be distinguished by comparatively fair complexions.

V. On the contrary, in a rainless tropical climate, or in one with a well-marked dry season, the rays of a vertical sun will continually, or for considerable periods, descend in all their power, and the blackest and densest pigment and the thickest scarf-skin will be needed. Between the tropics the nights are always long, and, in consequence, when in the dry season there is little moisture in the air to check radiation, the thermometer, as many African travelers have remarked, falls very low before sunrise. To withstand the loss of heat at such times a thick outer skin will be an advantage. Accordingly, in these climates, we find the blackest men and very thick skins.

This theory of the relations between the climate and the skin is, I

believe, in accord with the facts. The polar tribes are known to be yellow. Among them, more frequently than elsewhere, according to Quatrefages, occur cases of dry, rough skins. This I take to be a result of the thickness of the cuticle, just as, on the older parts of a tree, the roughness of the bark is a consequence of its thickness.

It is well known that the climate of Europe, where white men most abound, is more influenced by the sea than that of any other continent. With the inconsiderable exception of the Caspian and Arctic regions, where yellow men occur, it may all be said to be kept moist by breezes from warm tracts of water. The fairest members of the human family are found in the humid lands about the North and Baltic Seas, where the influence of the Gulf Stream is most felt, and where a temperate climate extends farther from the equator than elsewhere on the face of the globe. When we proceed eastward from the Baltic, the complexions gradually darken as the increasing range of the thermometer indicates increasing dryness. Moscow, Kazan, and Tomsk are all near the fifty-sixth parallel of north latitude. The difference between the temperatures of the warmest and coldest months at these places is respectively 53°, 61°, and 69° Fahr. At Moscow, the population consists of fair- and dark-haired whites. About Kazan, though there are still fair and dark whites, there are also yellow men. At Tomsk the entire native population belong to the yellow race.

That the climate of the whole of Asia, from the Hindoo-Koosh and Himalaya Mountains northward, may be considered dry, is shown by the extensive deserts and the great range of temperature in the countries where sufficient rain falls to render agriculture possible. For instance, in China and Japan the range of the thermometer is somewhat greater than in corresponding latitudes in the eastern United States. The entire population of this vast area is yellow, with insignificant exceptions on its western border.

The greater part of North America corresponds in climate with central and eastern Asia. But the meteorological phenomena of the coast of British Columbia and Alaska are similar to those of the northwest of Europe. Warm winds from the Pacific keep the temperature high and the air moist; but, owing to the configuration of the coast and the direction of the mountain-ranges, their influence does not extend far inland. The immense difference between the climatic conditions of the eastern and western coasts of America may be illustrated by comparing the temperatures of Sitka (57° 3′ N. L.) and Quebec (46° 49′ N. L.). Though the latter is more than ten degrees farther south, its mean annual temperature is two degrees less, and, while the difference between the means of the warmest and coldest months is fifty-seven degrees at Quebec, it is only twenty-five at Sitka.

It is a fact which strikingly corroborates the theory advanced in this paper, that it is precisely in the northwestern part of this conti-

nent that the fairest natives are found. The testimonies of the early explorers, which have been collected and arranged by Mr. Bancroft, of San Francisco, in his valuable work on the Indians of the Pacific coast, leave no doubt that, before there was any intermixture of European blood in this region, the complexion of the inhabitants was not very different from that of southern Europeans, that their skins transmitted a blush, and that fair and brown hair, ruddy cheeks, and light eyes were not uncommon among them.

Perhaps the best example of a perpetually humid tropical climate is afforded by the valley of the Amazons. In consequence, nearly the whole of the vast region drained by this stream is, like some parts of India and some of the East Indian islands, covered with a dense unbroken forest. Though heated by an equatorial sun, its natives are, not only not black, but, as has already been remarked, lighter-complexioned than those of the Peruvian Cordilleras.

Examples of perpetually dry tropical climates are furnished by the Nubian Desert and the southern part of the Sahara. These countries, together with southern Arabia, enjoy the hottest mean summer temperature known. The inhabitants, whether belonging to the Semitic, the Hamitic, or the negro race, are alike black. The Nubian Arabs are said to be as black as the blackest negroes.

The part of Africa south of the Great Desert will exemplify the case of a tropical climate with a dry season. This immense region consists essentially of a strip of low coast-land, and an immense level central depressed surface, with a more or less elevated rim inclosing it. The inhabitants of the coast and the central depression are very black, those of the rim lighter in color. Dr. Livingstone attributes this difference to the greater humidity of the lower regions. But it is obvious, from theoretical considerations, that the rim must be more humid than any other part of the continent. During the dry season the sea-breezes, when they strike the coast, will be raised in temperature, and consequently deposit no moisture, until cooled by being forced upward when they come against some elevated land. The meteorological observations made in Africa support this view. Along the coast there is everywhere one pronounced dry season, and in some places there are two. In Sierra Leone (8° N. L.), it lasts from November to May; at the mouth of the Gaboon (0°), from May to September. In Zanzibar (6° S. L.) there are eight rainless months; in Natal (25°–30° S. L.) seven. The central depressed regions exhibit similar phenomena. At Gondokoro (5° N. L.) there are five, at Ujiji (5° S. L.) there are eight rainless months. On the contrary, in the Usagara Mountains (6° S. L.), which are west of Zanzibar, and in the elevated equatorial region about the Victoria Nyanza, rain falls every month of the year.*

It was long ago remarked that the negro perspires less than the white. Pruner Bey has established by actual measurement that both

* Grisebach, "Vegetation der Erde."

his dermis and epidermis are thicker. I believe that these facts supply the explanation of the extreme unhealthiness of the African climate for the white man. His thin outer skin permits his system to be weakened by an undue loss of its fluids in the daytime and of its heat at night, and in this condition he falls an easy prey to some disease.

There are black men in Africa, India, and Australia, because these countries all have climates with long pronounced dry seasons. Owing to the peculiar formation of the continent of America, its tropical regions are more humid, and consequently no very dark natives are found there. Of the great Papuan race, which inhabits New Guinea and many smaller islands in that part of the Pacific, some branches are black and some brown; but I have not been able to procure meteorological data bearing on their case.

The climate and complexions of the rainless coast of Peru correspond very closely to those of the rainless valley of Egypt, the Peruvians being perhaps a shade darker. The dry climate of the tropical part of the Andes has even affected the color of the Spanish creoles; while in Cartagena and Guayaquil, towns with a humid climate on the seacoast of South America, their complexion is as light as that of native Spaniards, and fair hair still occurs, in Santa Fé, which is in the mountain country, only dark complexions with dark hair are found. Tschudi, indeed, asserts that the colder the climate (i. e., the greater the elevation), the darker the color in Peru.

Some of the evidence tending to show the connection of humidity and fairness in Africa is quite striking. In the mountainous region of Gambaragara, near the Albert Nyanza there lives, according to Stanley, a race whose fairness so struck him that he supposes that it must have come from the north. According to Lefebvre, the skin of the Abyssinians becomes lighter during the rainy season. The Bongo, Niam-Niam, and Monbuttoo tribes, whose fairness amazed Schweinfurth, inhabit a wooded and presumably a humid country, while the black Shillooks, with whom he contrasts them, dwell in a country adapted to pastoral purposes, and therefore probably dry. In the rainy regions of the Atlas Mountains there are said to be tribes among whom many individuals with blue eyes, fair skin, and red beard occur.

Similar phenomena recur in Asia. The blonde races of the Caucasus are found on its moist southern slope. The races on the dry northern declivity have a Tartar complexion. The moistest part of India is the jungle-covered southern slope of the Himalaya Mountains, and in this quarter, accordingly, we hear of white races. The Rohillas, an Aryan people, living northeast of Delhi, and the Lepchas, a Mongolian tribe, near Darjeeling, may be mentioned as examples. In the north of China proper there is a low-lying, swampy, and presumably somewhat moist peninsula called Shantung. There is some evidence tending to

show that the natives of this peninsula are fairer than the rest of the Chinese.*

If this theory be correct, it is the destiny of the white race in North America to approximate in color to the aborigines. Two causes at present, to a considerable extent, counteract the effects of climate. The first is the constant influx of immigrants from the Old World; the second, the fact that, until the great West is filled up, the struggle for existence can not become very severe, and the degree of cutaneous adaptation to climate can not assume great importance. But there are, nevertheless, indications that climatic influences are producing their natural effect. The unmixed descendants of the original settlers everywhere appear to have dark hair and a more or less sallow complexion. The writer can testify from personal observation that this is generally the case with the descendants of the united empire loyalists who settled after the Revolution in what is now the Province of Ontario. He can also testify to the darkness of the French Canadians, who derive their origin principally from Normandy, and therefore may be assumed to have at first included a large number of fair-complexioned individuals. It is remarkable that among this race a great many persons are to be seen whose features are more or less Indian in type. This, however, may (as Dr. Wilson, of University College, Toronto, supposes) be the result of an admixture of native blood.

However similar, physically, our descendants may, under the influence of climate, become to the Indians, it by no means follows that they will resemble them mentally or morally. The same struggle for existence that will eliminate the individuals ill adapted to the physical climate will also eliminate those ill adapted to the intellectual and spiritual climate, so that I am inclined to predict that the result will show, what history has indeed already established, that capacity for progress is not indissolubly connected with any particular hue.

It is obvious that on this hypothesis agreement in color does not prove, and disagreement does not disprove, community of origin. Guided by linguistic affinities, ethnologists have already in many cases disregarded color in their classifications. In the Indo-European family they include both the fair Teutons and the dark Hindoos. The white Finns and Magyars are classed with the yellow Ural-Altaic races. Black Arabs and white Jews go together in the Semitic group. But the principle has not been applied throughout. The Basques and the Caucasians, between whose languages and those of the Aryan family no relationship has ever been established, are generally considered to be nearer in blood to us than those members of the Ural-Altaic group who exemplify in the fullest degree the Indo-European type of *physique*. Hitherto the ethnological results of investigations into the physical characteristics of different races have been mainly negative;

* See a paper by J. Lamprey, in the "Transactions of the Ethnological Society" for 1867.

the principal valuable positive conclusions have been derived from linguistic researches. In the dispute as to the relative merits of the zoölogical and philological methods in ethnology, I accordingly side with the advocates of the latter; and, in regard to the special subject of this paper, I say with Quatrefages, in the words of Virgil, "*Ne crede colori.*"

THE CARBON BUTTON.*

By E. A. ENGLER, A. M.

ALTHOUGH the telephone seems to have sprung up among us very suddenly, there have been steps in its development which show that the difficulties encountered in devising a means for the transmission of articulate speech have not been overcome altogether by a single stroke of individual genius, but singly by the patient and, for the most part, unrewarded labor of many. Each stage of its development was the outgrowth of suggestions obtained from previous experiments. Of the instruments which served their purpose in the discovery of the properties of the carbon button, a brief description will be given in this paper.

Sound is known to be produced by vibrations, generally of air; differences between sounds are due to differences in vibration. There are but three essential characteristics to be noted, all dependent upon the vibrations of the air: 1. The pitch, by virtue of which a sound is called high or low, and which depends upon the number or rapidity of the vibrations; 2. The intensity or loudness, which is determined by the amplitude of the vibration; 3. The quality by which we distinguish the corresponding tones of different instruments, and which depends on the form of the vibration. In order to obtain an exact reproduction of any sound, its pitch, intensity, and quality must be exactly reproduced; and, to render this possible, the rapidity, amplitude, and form of the vibration must be exactly reproduced.

For producing sound at a distant place two methods suggest themselves: 1. Actually to transmit the sound vibrations through the air; this is the method employed in the speaking tube. 2. To reproduce the sound vibrations at the distant station; this is the method employed in the telephone. The previous development of the telegraph naturally suggested electricity as the agent to carry the vibrations from one place to another. It thus became necessary to convert sound waves into electric waves and *vice versa*, and experiments look-

* This paper, at first intended for a special occasion, has been published at the suggestion of several friends. In its preparation, use has been made of information to be found in George B. Prescott's work on the telephone, and in the journals of science. Most of the illustrations are from Prescott's work.

ing to the accomplishment of that end were begun nearly twenty years ago.

The first successful experiments were made by Philip Reis, of Fredericksdorf, Germany, in 1861. He argued that if it could be found practicable to convert sound pulsations into electric pulsations, and then convert these pulsations back again into sound pulsations, the same effect would be produced as if the vibrations had been actually transmitted through the air. In his instruments a membrane rigidly secured on the sides was caused to vibrate in the center by the motion of the air produced by any sound. In the center of this membrane was a delicate circuit-breaker so arranged as to break the circuit of an electric telegraph line at every vibration, thus successively magnetizing and demagnetizing an electro-magnet at the receiving station, and causing its armature to vibrate in accordance with the vibrations of the membrane at the transmitting station. The vibrations of this armature, properly mounted on a sounding-board, set into vibration the surrounding air, which carried the sound to the ear. His first instrument is represented in Fig. 1. A is the transmitting and B the receiving instrument, supposed to be placed at different stations and connected with each other by a metallic conductor. A conical tube, *a b*, six inches long, four inches in diameter at the larger, and one and a half inch in diameter at the smaller end, is closed at *b* by a collodion membrane *o*, against the center of which rests one end, *c*, of the lever *c d*. This lever has electric connection with the wire of the line joining the two stations at its point of support, *e*. The end *d* of the lever rests against the flat spring *g*, which can be properly adjusted by means of the screw *h*, and which, through the metal standard *f*, is connected with the battery C. At station B the conducting wire passed around the electro-magnet *m*, which is mounted on a sounding-box W; thence to the ground. Attached to the armature at the pole of the magnet is a thin plate *i*, which is hung on an horizontal axis projecting from the upright *k*; the motion of the plate can be regulated by the screw *l* and the spring *s*. The best dimensions and most suitable adjustments of the instrument were determined by experiment. Its operation is as follows: When at rest the small spring *n* keeps the lever *c d* in contact at *g*, the circuit is closed, and the magnet *m* attracts the armature *i*. But, when by speaking into the tube *a b*, the air in the tube and therefore the membrane *o* is set into vibration, the contact at *g* is alternately broken and closed, and consequently the magnet at B is demagnetized and magnetized, alternately releasing and attracting the armature *i*. It is evident that the vibrations of *i* correspond in number and interval to the vibrations of the membrane *o*; so that the sound which enters the tube *a b* is reproduced at B so far as its pitch is concerned. But as the strength of the current is constant, neither the intensity nor the quality of the sound is reproduced.

In 1874 Elisha Gray, of Chicago, accomplished the reproduction of

intensity and quality as well as pitch of sound by means of an instrument in which the strength of the current could be varied in exact accordance with the tone to be transmitted, and was thus enabled to

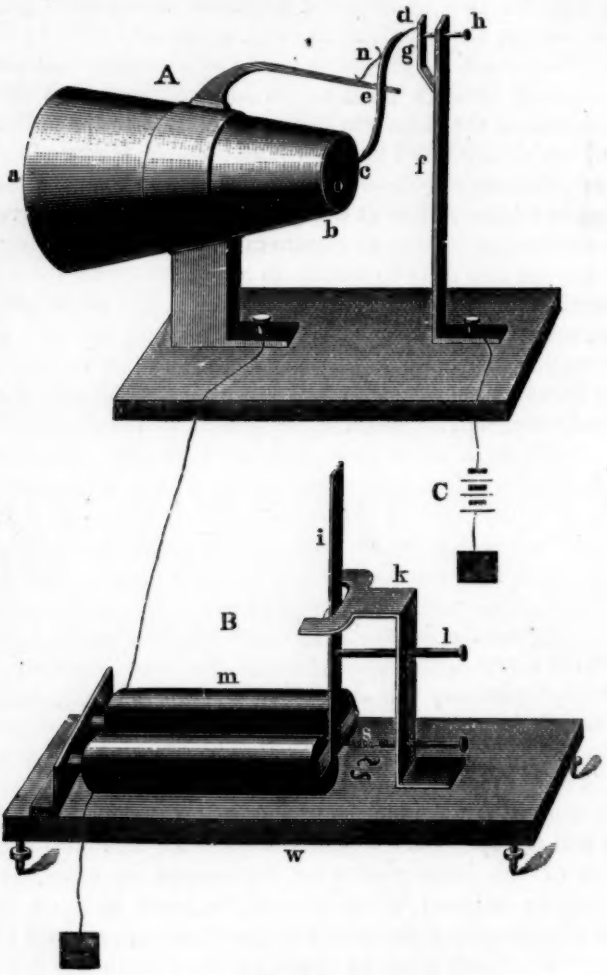

FIG. 1.

reproduce any number of tones simultaneously without losing their specific character—a thing plainly impossible with the Reis instrument. The device used is shown in Fig. 2. T_1 is a mouthpiece into which the person transmitting sounds speaks. D_1 is a tense thin diaphragm connected with the line joining the two stations. To the center of the diaphragm is fastened one end of a metal rod N, whose other end dips into a jar J containing acidulated water. A metal plug

p at the bottom of this jar is connected with one wire of the battery E, the other going to the ground. At the receiving station the wire simply passes over an electro-magnet H, thence to the ground. Close to H is placed the diaphragm D, properly provided at its center with a metal plate which serves as armature for the electro-magnet, and fastened at its circumference in the holder T. The action of the in-

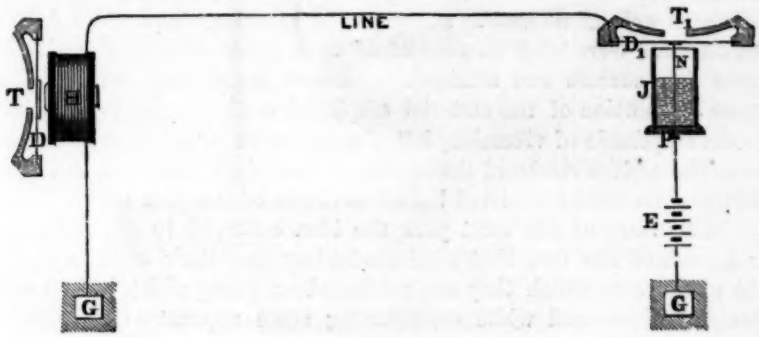

FIG. 2.

strument is as follows: The person sending the message speaks into the mouthpiece T_1, thus causing the diaphragm D_1, with the plunger N, to vibrate. The greater the amplitude of vibration the deeper the rod N descends into the liquid, and therefore the thinner the stratum of liquid through which the current will have to pass; thus the resistance to the passage of the current is varied inversely as the intensity of the sound. At the receiving station the current magnetizes the electro-magnet H, and thus reproduces in the diaphragm D the vibrations of the diaphragm D_1.

A number of telephones have since been invented, differing from each other in method of application and details of construction, but all embodying the scientific principle used by Gray.

Using the instrument invented by Reis, and the suggestions which Gray's experiments afforded, Thomas A. Edison began his attempts to construct a new form of telephone. Inasmuch as his experiments in this direction "cover many thousand pages of manuscript," only a few of the more characteristic ones will be given.

In the Reis transmitter a platinum screw was made to face the diaphragm, and a drop of water was put between them. The only result, however, was the decomposition of the water and the deposit of a sediment on the platinum. Two disks of platinum, one on the diaphragm and the other on the screw, so placed as to hold several drops of water by capillary attraction, were then tried. Acidulated solutions were substituted for water; paper and other materials, saturated with various solutions, were tried; sharp edges were substituted for disks. The result of all these experiments was complete failure, on

account of the decomposition of the fluids. These were therefore abandoned and the attempt was made to vary the strength of the current by the use of platinum points, springs, and other devices. The number of these points which was to be brought into the electric circuit was to be dependent upon the amplitude of the vibration, and thus the resistance of the circuit was to be varied inversely as the intensity of the sound producing the vibration. All of these contrivances were of no avail. Subsequently plumbago and white Arkansas oil-stone were tried on account of their great resistance, and with these fair success was attained. Various expedients were used to make the portion of the material employed in the circuit proportional to the amplitude of vibration, but the confusion introduced by the devices themselves rendered the apparatus practically useless. All these experiments were conducted before the close of the year 1876.

In January of the next year the idea occurred to Mr. Edison to make use of the fact that semi-conductors vary their resistance with the pressure to which they are subjected—a thing which he had accidentally discovered while constructing some apparatus for artificial cables about four years before. He immediately set to work to construct an instrument. A diaphragm carrying at its center a spring faced with platinum was placed opposite to a small cup containing the semi-conductor to be tried. The adjustment was secured by means of a screw fastened to the cup. The vibrations of the diaphragm produced by the tones of the voice determined the pressure of the spring upon the semi-conductor. The materials first experimented upon were crude plumbago mixed with dry powders of different kinds. The results obtained were encouraging, the volume of sound being great, but the articulation so poor that some practice was necessary before the peculiar sound of the instrument could be caught with ease. An improvement was effected when, after much experimenting, solid materials were abandoned and tufts of gloss silk coated with semi-conductors were substituted. But, with all the improvement that could be devised, the instrument was still very inferior to the magneto-telephone of Professor Bell, and required such frequent adjustment as to make it very objectionable. Experiment developed the fact that the change in resistance in the semi-conductor, due to the impact of sound-vibrations, was very small, and, in order to make this change of resistance as important a factor as possible, Mr. Edison determined to make the resistance of his circuit very small: to that end he tried the primary circuit of an induction-coil, but the experiment failed. The cause of failure was at first only a matter of conjecture; but, by trying one thing after another as they suggested themselves, without any very definite purpose, conjecture finally condensed into the belief that the resistance of the semi-conductor was too great to be used with the primary circuit of an induction-coil. The effort then was to reduce the resistance of the semi-conductor to a few ohms and still be able to

vary its resistance by the pressure caused by the vibrations of the diaphragm. To effect this a small circular piece, technically termed "button," of the semi-conductor was placed between two platinum disks in a small cup. Electric connection between the disks and the button was secured by inserting a small piece of rubber tubing. The first button was made of solid plumbago, and the results were quite excellent; but still the instrument was inferior to the Bell telephone. Experiments were then made upon many materials in order to obtain a button whose resistance, though small, could be greatly varied; and, when the list of substances, natural and artificial, had been wellnigh exhausted, without very satisfactory result, a fortunate accident led to the solution of the difficulty. A small quantity of lampblack had been taken from the chimney of a smoking petroleum-lamp and preserved as a curiosity on account of its intensely black color. This substance was now tried as, it would seem, a *dernier ressort*. The results were excellent beyond all hope, the articulation very distinct, and the volume several times as great as could be obtained with a magneto-telephone. It was found that the resistance could be varied by pressure alone from three hundred ohms to the fractional part of a single ohm. Fig. 3 shows an instrument used for the experimental deter-

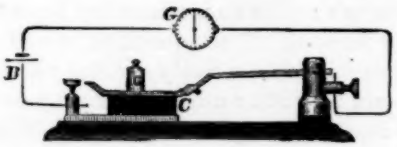

FIG. 3.

mination of the change of resistance due to pressure only. C is a piece of carbon placed between two metallic plates which are connected with the battery, B, in whose circuit is also the galvanometer G. As the current passes it must go through the carbon, the pressure on which can be varied by changing the weights placed upon it. The deflections of the galvanometer-needle indicated that the resistance of the carbon varied inversely as the pressure to which it is subjected. The best arrangement proved to be to make the resistance of the circuit $\frac{6}{10}$ of an ohm, while the normal resistance of the carbon itself was three ohms.

Good results were obtained with other materials besides carbon; the following is a list of the six most useful substances for this purpose in the order of their value: 1. Lampblack; 2. Hyperoxide of lead; 3. Iodide of copper; 4. Graphite; 5. Gas-carbon; 6. Platinum-black.

In the manufacture of the carbon button great care has to be taken that the deposit of lampblack be obtained at the lowest possible temperature, and untouched by the flame; otherwise it is utterly useless for the purpose. Thus commercial lampblack offers very great resist-

ance to the passage of the electric current, and for that reason can not be used at all. The lampblack taken from the chimney is laid upon a white slab, where the brown portions are readily detected and removed. The pure black portion is then ground and subjected to a pressure of several thousand pounds in a mold. It is then repowdered and repressed several times, and finally molded into buttons weighing three hundred milligrammes each.

The special advantages of the carbon button over buttons of other materials are notably its sensitiveness to very slight changes of pressure, its remarkable elasticity and its delicacy over a long range of absolute pressures. These properties it possesses in a higher degree than any other substance, and the explanation of this peculiarity has been found in certain of its physical characteristics. Microscopic examination has shown that, of all finely divided substances, whether obtained by chemical or mechanical means, lampblack is the most finely divided. Now, it is known that the change in resistance of any piece of finely divided material, caused by change of pressure, is due to the increase or diminution of the number of particles brought into contact with each other. On this account a given change of pressure will show a greater change of resistance in carbon than in any other substance. Moreover, with other materials, a point is soon reached when additional pressure ceases to produce any appreciable change in resistance, doubtless because all the particles are already in contact. But the fact that lampblack is so finely divided enables it to respond to changes of pressure long after other materials have lost their sensitiveness. For this reason a comparatively large initial pressure can be used with the carbon, and the instrument is not so easily thrown out of adjustment. That the greater delicacy of the lampblack is due to the fact that it is so finely divided has been confirmed by experiments made with gas-retort carbon, the particles of which are comparatively coarse, graphite, which is more finely divided, and lampblack, whose particles are the finest of all. The changes of resistance for a given change of pressure were found to be proportional to the number of particles in a given volume, or inversely proportional to the size of the particles. By microscopic comparison between a Rutherford diffraction grating having 17,291 lines ruled to the inch on a piece of speculum metal, Mr. Edison estimated that there could not be less than 10,000,000 points in contact in the carbon-button when used in the telephone. This must, however, be regarded only as an approximation.

The only defect in the carbon button is its friability. But, when properly armatured, it need receive no violent shock, and will last as long as necessary. Even if it should happen to become cracked, the volume of sound would not be materially lessened. Experiments have been made to harden the button by mixing various substances with the carbon, and then subjecting the mixtures to high temperatures.

Though all these processes tend to impair the delicacy of the button, it is still far superior to a button made of any other substance.

The first application made of the carbon button was in the telephone. The arrangement of the apparatus is shown in Fig. 4. The carbon button, E, is placed between two platinum plates, D and G, which are in the circuit of a battery, as shown by the figure. Upon the upper platinum, D, is placed an ivory plate, C. A piece of rubber

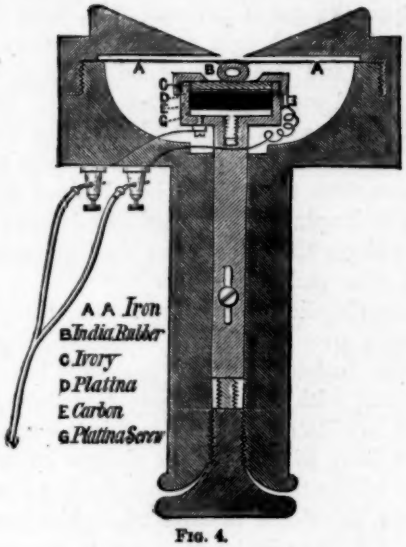

FIG. 4.

tubing, B, connects the ivory with the vibrating diaphragm, A A. All this is inclosed in a hard-rubber case with suitable mouthpiece and adjusting apparatus. The vibrations of the diaphragm communicated through the rubber cause variations in the pressure upon the carbon, and corresponding variations in the strength of the current which traverses the wire. At the receiving station an instrument similar to the one already described, invented by Gray, may be used.

At first the diaphragm was made so delicate that it continued to vibrate an appreciable time after the cause which set it in vibration ceased to act, at least long enough to cause an interference in articulation due to the mingling of successive vibrations. The object of the piece of rubber was to dampen the vibrations of the diaphragm, or to bring the diaphragm quickly to rest after it has been set in motion by a sound. The rubber was found to be somewhat tardy in its action; at best the sound emitted was muffled. The rubber had the additional disadvantage of becoming somewhat flattened with use, thus necessitating readjustment. Experiments were then made to find something which would bring the diaphragm to rest more quickly than the rubber could, and for that purpose a thin spiral metallic spring was sub-

stituted. But the spring itself gave out a tone when the diaphragm was in vibration, and was therefore objectionable. To overcome this difficulty thicker wire was used for the spring, and with better results. Trials were made with wires of different thicknesses, and it was found that the results improved as the thickness of the wire was increased, until finally the best results were obtained by using a piece of solid material rigidly secured to the diaphragm and ivory plate. It then occurred to Mr. Edison that, inasmuch as the working of his instrument depended upon changes of pressure only, there would be no need of having a vibrating diaphragm at all. A heavy diaphragm was therefore constructed and rigidly fastened to the carbon disk, so that the loudest tones would produce no vibration in it. With this arrangement the articulation was perfect, and, because the comparatively large area of the inflexible plate produced a greater pressure upon the carbon for a given tone than could be obtained when only the one point of the plate or diaphragm was used, the volume of sound was so magnified that a whisper three feet from the instrument was distinctly intelligible at the other end of the line.

Besides greater simplicity of construction, the carbon telephone possesses advantages over all others. With the telephone, as with an ordinary telegraphic instrument, there is a limit beyond which it fails to be of service, but with the telephone this limit is sooner reached than with the ordinary instruments. For this two causes are assigned: 1. The greater rapidity with which the electric impulses are sent over the line in the use of the telephone allows the line less time for charge and discharge than in Morse circuits where the transmission is done by hand; 2. The inductive action of currents passing through neighboring wires often renders the signals indistinguishable. These disturbances occur with all telephones, but they are least noticeable with the carbon telephone, because with it a stronger current is used, and therefore less sensitive receivers are required. Mr. Henry Bentley, President of the Local Telegraph Company at Philadelphia, made a set of experiments with this apparatus upon the lines of the Western Union Telegraph Company, which were on poles along with other wires through which currents were passing sufficiently strong to render the magneto-telephone useless, and found it entirely successful for a distance of from one hundred to two hundred miles. He has succeeded in using it upon a line seven hundred and twenty miles long. His experiments also show that the instrument can be used in a Morse circuit with a battery and eight or ten way-stations, using the ordinary telegraphic apparatus. It can also be used upon a wire which is at the same time being worked quadruplex.

The carbon telephone is rendered even more efficient when used in connection with the electro-motograph receiver.* For the follow-

* For a description of the motograph the reader is referred to Edwin M. Fox's article in "Scribner's Monthly," June, 1879.

ing drawing and description, given with the sanction and approval of Mr. Edison, the writer is indebted to the courtesy of Mr. S. D. Mott, of Edison's laboratory :

"The course and action of the currents in Edison's loud-speaking telephone are as follows: Reference is made to the accompanying dia-

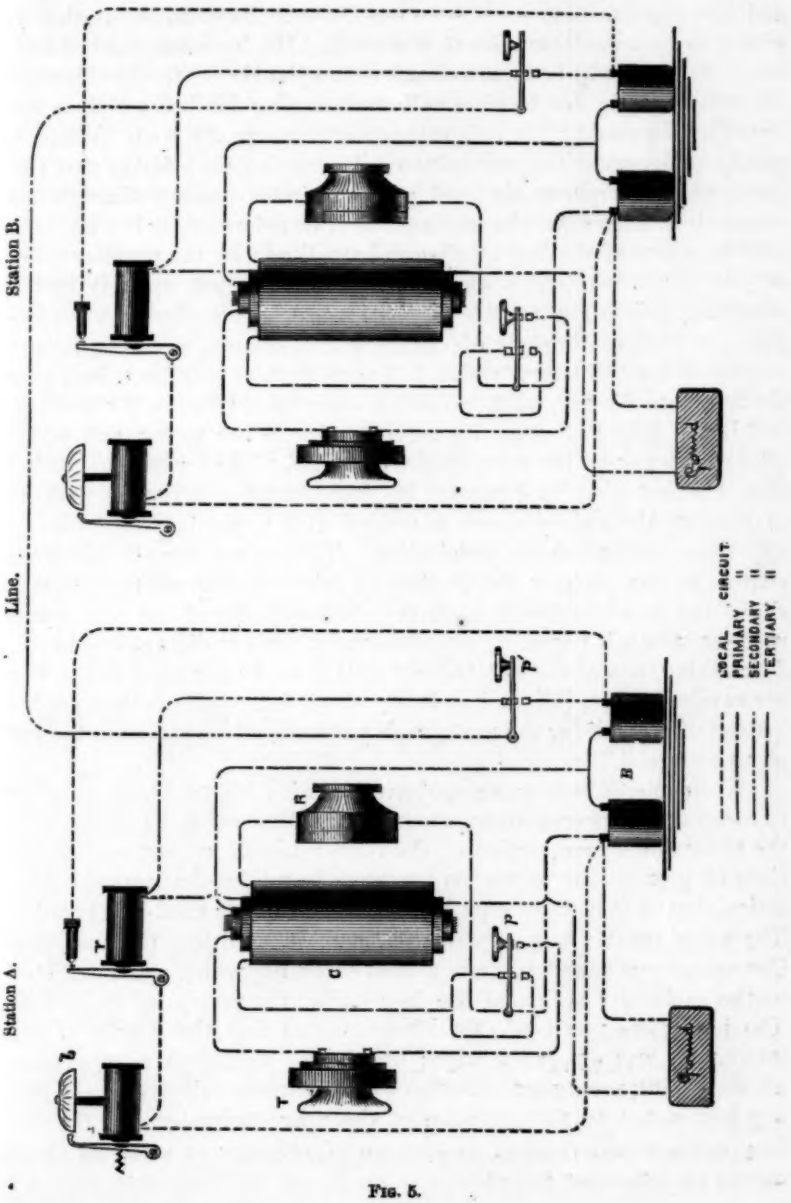

FIG. 5.

gram, Fig. 5, which represents the termini of a telephone-line; C, the induction coil, consisting of a primary, secondary, and tertiary circuit; T, the carbon transmitter; R, the electro-motograph receiver; B, battery; *r*, relay; *b*, bell; *p*, push-button; and *p'*, bell-button. The local circuit is represented in dotted lines (- - - -); the primary thus —— - - —— - - ——; the secondary thus —— - - - —— - - - ——; and the tertiary thus —— —— —— ——. Suppose A, station 1, wishes to communicate with B, station 2. He depresses the bell-button *p'*, when, it will be seen, a circuit is completed over the line through B's relay, closing his local circuit and ringing his bell; B then answers by depressing his bell-button and ringing A's bell. When A speaks he depresses his push-button *p* connecting his primary and tertiary, which completes his local primary circuit passing through the transmitter, where the electric impulse is transformed, as it were, into electric waves of varying number and amplitude by the peculiar property of the carbon button as varying pressure is put upon it by the vibrating diaphragm actuated by the voice. This electric wave-impulse, in passing through A's primary coil, induces a corresponding current in his secondary, which is transmitted, as may be traced over the line, into B's coil, when induction again takes place in B's tertiary, and B will then hear from his receiver what A has to say, and transmits his answer by the same *modus operandi*. The second connection that A makes when he depresses his push-button *p* is for the purpose of keeping his tertiary closed in order that B might interrupt him at any time during the communication. The reason for the alternate contact of the primary and tertiary at *p* is that each contact gives a slight but harmless knock upon the chalk cylinder of the motograph receiver, which, if occurring simultaneously, tends to disrupt its surface. For talking, one of the two Callaud cells is used; for the bell the two are required. Mr. Edison has lately adopted a small electric engine instead of a crank for the motograph purposes, which occasions the use of an extra cell."

While Mr. Edison was experimenting with his telephone in order to ascertain the proper arrangement of the diaphragm, he found that the expansion or contraction of the rubber handle caused such variations of pressure on the carbon button as to render the instrument inarticulate and sometimes even inoperative. He then tried iron handles. The same trouble was experienced, and, in addition, the receiving instrument was found to emit a kind of sound, which was attributed to the molecular action of the iron during the process of expansion. The immediate result of this discovery was that the handle of the instrument was dispensed with; but it also furnished a suggestion which, calling prominent attention to the extreme delicacy of the carbon button, led to the invention of the micro-tasimeter. If the carbon button would respond to changes of pressure as small as those caused by molecular action in the handle of the telephone, it would

also serve as a means of measuring such small differences of pressure, and thus furnish a comparison between the causes which produced them. The essential principle of the tasimeter is shown in Fig. 6.

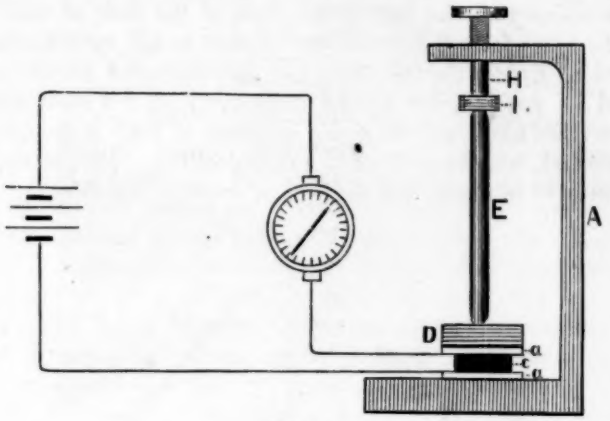

FIG. 6.

A firm standard, A, holds at its upper end a screw which works against a follower, H, to which is attached the metal cup, I. At the base, between two platinum plates, *a*, *a*, is the carbon, C; the platinum plates are in a battery circuit provided with a galvanometer. Upon the upper platinum rests a metallic cup, D. Between the two cups, I and D, is placed a piece, E, of any material upon which experiment is to be made. The expansions and contractions of E cause changes of pressure upon the carbon, and thus changes of resistance in the electric circuit which are indicated by the galvanometer. The screw-head is turned until the initial pressure is sufficient to deflect the needle a few degrees. After the needle comes to rest, the slightest change of pressure will be indicated. The delicacy of the instrument depends largely upon the coefficient of expansion of the material used at E. With a piece of hard rubber, upon which the heat from the hand placed a few inches away is allowed to act, there is a deflection in the needle of a galvanometer which is insensible to the action of a thermopile facing a red-hot iron near at hand. When extreme delicacy is required, a Thomson's reflecting galvanometer is employed in a Wheatstone bridge in the way indicated in Fig. 7. The tasimeter is placed at *i*, and adjusted to a given resistance. The resistance at *a*, *b*, *c*, is made the same. The galvanometer is placed at G, and the minutest change of resistance at *i* is indicated at the galvanometer scale.

The instrument is of service for a variety of uses. It is an excellent device for detecting and measuring small and almost inappreciable quantities of heat. In the total eclipse of the sun in 1878, by the aid

of the tasimeter, what was previously only a matter of conjecture was proved to be a certainty—that the corona of the sun emits heat. The apparatus above described was arranged with as much care as possible, so that the smallest amount of heat might be detected. So great was the delicacy of the instrument that, at the time of total eclipse, when the beam from the corona was allowed to fall upon the tasimeter, the spot of light reflected from the galvanometer mirror not only changed its position, but moved completely off the scale which had been provided; so that, while the presence of heat in the corona was demonstrated, measurement of it was impossible. The instrument has also been used in measuring the heat of some of the stars.

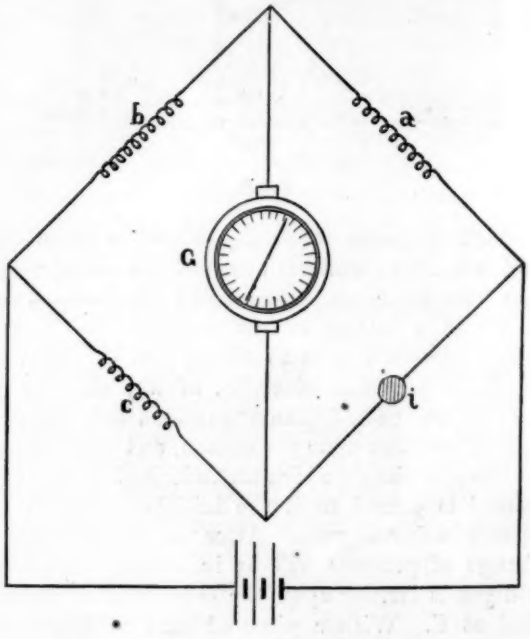

FIG. 7.

Besides being used as a delicate thermometer, the tasimeter also serves as a means of determining the coefficient of expansion of bodies; for, by having a micrometer screw attachment, the amount of expansion can be readily determined. By turning the screw, when the needle has been deflected, until it is brought back to zero, the increase in length can be read by the number of turns or parts of a turn the screw has been moved. Fig. 8 gives a section of the tasimeter, showing the micrometer screw. The piece of material to be tested is seen at A, being clamped rigidly at B, and resting in a metal socket M, which rests upon the carbon placed in the battery circuit as indicated.

The object of the funnel-shaped opening, with a small slit facing A, is to cut off all heat which is not wanted.

The tasimeter can also be used as a delicate hygrometer; by insert-

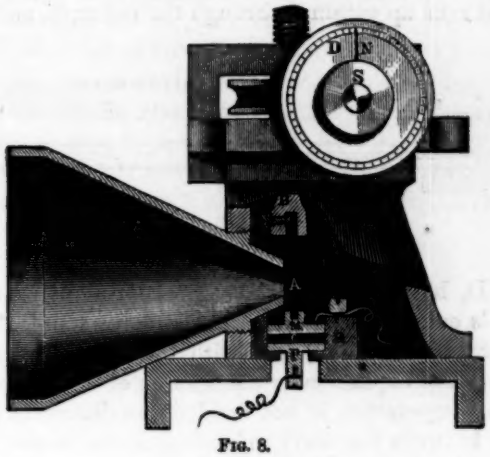

Fig. 8.

ing a piece of any substance which is capable of changing in volume as the effect of a change in moisture in the air, the pressure on the carbon will be varied accordingly and indicated by the galvanometer.

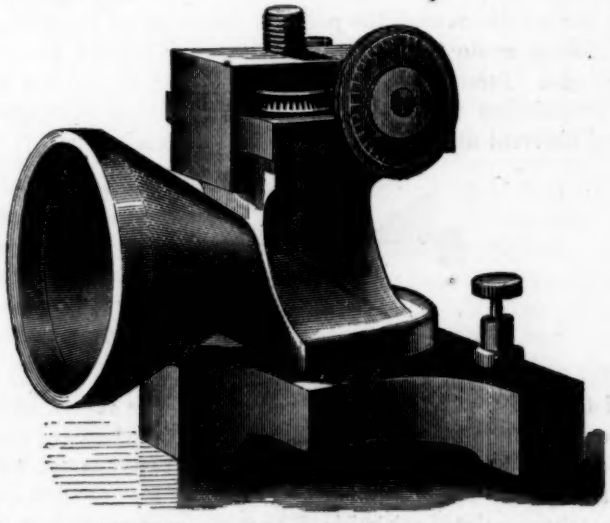

Fig. 9.—Perspective view of Micro-tasimeter.

The great sensitiveness of this instrument makes it seem probable that it will be used for many purposes not at present thought of. Special modifications for particular purposes are always possible. Fig.

10 shows a special application of the principle of the tasimeter devised at my suggestion by Professor C. A. Smith, of Washington University, St. Louis. A is a silver tube securely fastened at the top into a brass collar E. At the lower end, *o*, a steel rod, B, is firmly joined to the silver tube and runs up within it through the collar, E, and the carbon,

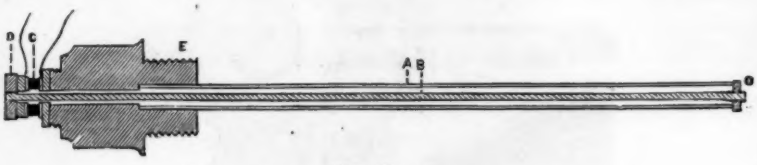

FIG. 10.

C, to a nut, D, by which the whole is clamped together. At E a screw-thread is cut, so that a brass tube, somewhat larger and longer than the silver tube, may be joined with the instrument for purposes of protection. The expansion or contraction of the silver tube, or, if the change in temperature is not sudden, the difference in expansion or contraction between the silver and the steel determines the variation of pressure on the carbon. It is proposed to use this instrument in determining the changes of temperature in steam cylinders, the laws of motion of a fluid whose temperature is not uniform, the rapidity of mixture when fluids of different temperatures are brought together, and the number of thermal units in any given volume of fluid.

After having discovered the peculiar properties of the carbon button, Mr. Edison made the current pass through several carbon disks instead of one. Increase in the intensity of the sound was noticed, but the articulation was impaired. The experiment was tried in a number of different devices, one of which is shown in Fig. 11. Instru-

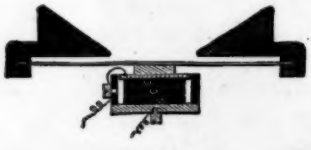

FIG. 11.

ments of this class, whose object is to magnify the sound, have come to be known as microphones, though it is doubtful if any of them succeeded in transmitting very faint sounds so that they could be intelligible at a distance.

Intimately associated with Mr. Edison's discovery and use of the properties of the carbon button are the experiments of Professor Hughes, of London. In May, 1878, Professor Hughes made the following discovery: He took a short glass tube and filled it with white silver powder, a mixture of tin and zinc. The ends of the tube were

closed with plugs of gas-carbon, and the plugs secured by covering them with sealing-wax. The carbon plugs were connected with the wires of a battery in whose circuit was a galvanometer, Fig. 12. When the tube is held in the hand and subjected to a longitudinal ten-

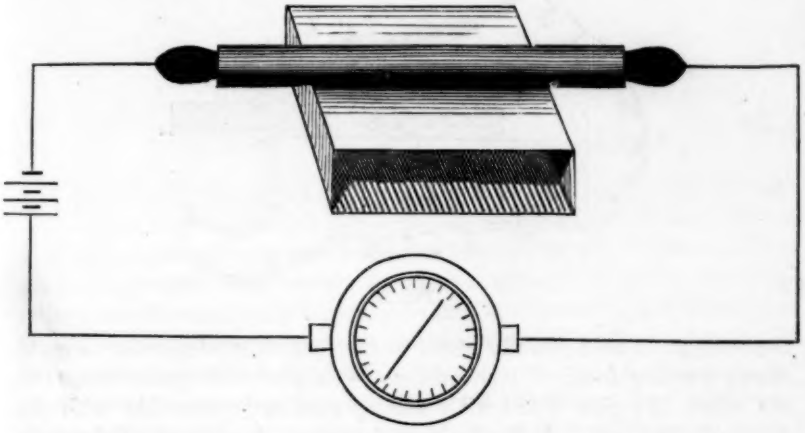

FIG. 12.

sile strain, the needle of the galvanometer is deflected in one direction; when the tensile strain is changed to a compression, the needle is deflected in the opposite direction. The explanation offered is that, when the tube is stretched, the number of particles of powder in contact with each other, and therefore the intensity of the current, is diminished; when the tube is compressed, the number of particles of powder in contact with each other, and therefore the intensity of the current, is increased. Moreover, this instrument is so sensitive that it is capable of taking up the vibrations of any sound, and of varying the electric current in accordance with them, so that the sound is reproduced at a distance in an ordinary telephone which may be placed in the circuit. If the tube is placed upon a resonating-box, the delicacy is increased. The tube in such an arrangement serves as the transmitting and the telephone as the receiving instrument. Other substances may be substituted for the white silver powder with good results. It is essential, however, that the substance used be not homogeneous. A piece of vegetable carbon plunged when incandescent into a mercury-bath, so that it becomes impregnated with particles of mercury, when placed in the tube, works quite well; pure vegetable carbon, on the contrary, is useless on account of its high resistance. Another form of transmitter is shown in Fig. 13. A piece of carbon, A, is hung on two arms, C, by a metal pivot, and rests at one end on a piece of metallized carbon, D, placed upon a piece of sealing-wax. The arrangement of the wires can be understood by the figure. Variations of

pressure upon D produce variations of intensity in the current. This crude instrument is so delicate that even the tread of a fly produces a sufficient change of pressure, and consequent change of intensity in

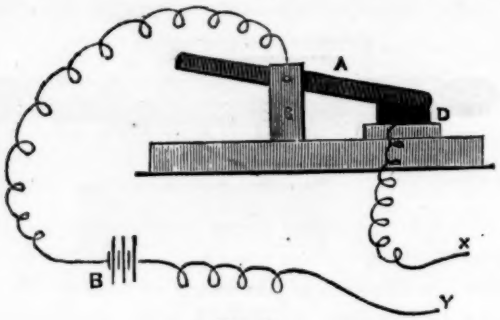

FIG. 13.

the current, to be distinctly heard in the receiving telephone. Fig. 14 shows another form of transmitter. Two pieces of gas-carbon, C C, are stuck to a pine board with sealing-wax, and connected with the wires of a battery. A third piece of carbon, A, pointed at the ends, rests loosely between them. This instrument will transmit low sounds

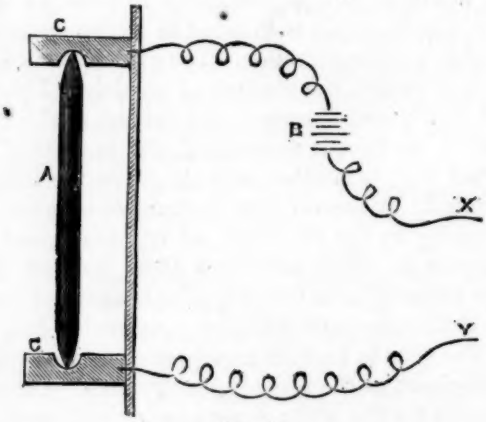

FIG. 14.

uttered at a distance from it of several yards. The capacity of the two instruments last described for transmitting sounds seems to depend upon the fact that the current is made to pass through an imperfect contact, which, when acted upon by the vibrations of sound, gives to the current an undulatory character. Successful experiments have been made with loose-jointed machinery used as a transmitter. Even a common nail laid loosely across two other nails, insulated from each other but connected with a battery, will make a good transmitter.

That the full outcome of these discoveries has not yet been reached there can be no doubt. Speculation in such matters is easy; but facts developed are sufficiently wonderful to command deepest admiration, without conjecture as to future possibilities.

GOD AND NATURE.

By the Right Rev. the LORD BISHOP OF CARLISLE.

AN elderly clergyman, dying some years ago in the east of London, bequeathed his silver spoons and the like to his nephews and nieces. But the spoons could nowhere be found. Ultimately they were discovered in a closet beneath a pile of sermons; the good clergyman having, for the sake of safety, chosen for his little stock of plate the place in which, as he imagined, it was most likely to be permitted to remain undisturbed.

I fear that I committed a mistake not long since by doing something analogous to that which was done by him whose providence I have just now chronicled, though with a different intention. I printed, in the form of an Appendix to a volume of "Oxford and Cambridge Sermons," a note on "Matter," for some portion of which, at least, I should like to crave more consideration than perhaps it has already received. The following paragraph contains the thought which I wish just now to put before the reader and to develop in this essay:

"I have referred to Cudworth's discussion of theories of matter with regard to the possible atheistic tendencies of some of them; and the time has not gone by, perhaps it never will, when the fear of atheism, as growing out of physical theories, will have ceased to exist. I am by no means prepared to say that there is no ground for such fear; but I think that some portion at least of the danger of science being found to have atheistic tendencies would be got rid of, if a clearer view could be obtained of the manner in which it is possible to establish a connection between physical theories and atheistic conclusions. It seems to me that we want a new word to express the fact that all physical science, properly so called, is compelled by its very nature to take no account of the being of God: as soon as it does this, it trenches upon theology, and ceases to be physical science. If I might coin a word, I should say that science was *atheous*, and therefore could not be *atheistic;* that is to say, its investigations and reasonings are by agreement conversant simply with observed facts and conclusions drawn from them, and in this sense it is *atheous*, or without recognition of God. And, because it is so, it does not in any way trench upon *theism* or *theology*, and can not be *atheistic*, or in the condition of denying the being of God. Take the case of physical astronomy.

To the mathematician the mechanics of the heavens are in no way different from the mechanics of a clock. It is true that the clock must have had a maker; but the mathematician, who investigates any problem connected with its mechanism, has nothing to do with him as such. The spring, the wheels, the escapement, and the rest of the works are all in their proper places somehow, and it matters nothing to the mathematician how they came there. As a mathematician the investigator of clock-motion takes no account of the existence of clockmakers; but he does not *deny* their existence; he has no hostile feeling toward them; he may be on the very best of terms with many of them; it may be at the request of one of them who has invented some new movement that he has undertaken his investigations. Precisely in the same way the man who investigates the mechanics of the heavens finds a complicated system of motion, a number of bodies mutually attracting each other and moving according to certain assumed laws. In working out the results of his assumed laws, the mathematician has no reason to consider how the bodies came to be as they are; that they are as they are is not only enough for him, but it would be utterly beyond his province to inquire how they came so to be. Therefore, *so far as his investigations are concerned*, there is no God; or, to use the word above suggested, his investigations are *atheous*. But they are not *atheistic;* and he may carry on his work, not merely without fearing the Psalmist's condemnation of the fool, but with the full persuasion that the results of his labors will tend to the honor and glory of God."*

The thought contained in this paragraph, and which may be said to be compressed in the word *atheous*, appears to me to be interesting intellectually, and valuable morally. It is not desirable that the reproach of atheism should be thrown about rashly. That there is such a thing as atheism, and that the atheistic condition of mind may be not only a very miserable, but also a very immoral one, I would not venture to deny; but that charges of atheism are not unfrequently rashly made, and the attitude taken up by scientific investigators is sometimes regarded as atheistic when it is not fairly to be described by that terrible epithet, is also true. Physical science is not more essentially atheistic than arithmetical or geometrical: all three are atheous, not one is atheistic.

Yet God and nature are very close the one to the other: the *natura naturans* and the *natura naturata* must necessarily be contiguous. We need a "scientific frontier" between them, a line which shall on no condition be transgressed by those who occupy the territory on one side or the other.

The necessity of keeping this frontier line sacred is perhaps not sufficiently recognized, and there is a great tendency to transgress it; but it is not a mere arbitrary line to be laid down by treaty, as the

* "Oxford and Cambridge Sermons," p. 280. (George Bell & Sons.)

boundaries of adjacent states are settled, but is like one of the great watersheds of nature, which no human arrangement can alter: it is like the "great divide" in the Rocky Mountains, one side of which means for every drop of rain that falls a passage to the Pacific, and the other side means a passage to the Atlantic. On a smaller scale there are similar edges on Snowdon and Helvellyn; you may stand upon them and throw two pebbles with the right hand and with the left, which will be miles apart before they come to rest.

For, in truth, the difference between the two territories, separated by our supposed scientific boundary, is greater than that which is expressed by the terms *natura naturans* and *natura naturata*.* The conception of a *natura naturans* might be merely that of a first cause, a logical beginning of nature, without any of those moral attributes which men with almost one consent associate with the name and conception of God. If the transgression of the legitimate boundaries of the field of physical science merely introduced the inquirer to metaphysical speculations, no harm would ensue, though possibly not much advantage. The condition and quality of mind which make a man a successful investigator of nature, either by the way of observation or by that of mathematical analysis, are seldom associated with those mental powers which enable a man to get beneath the surface of phenomena and speculate with any success as to the ground and underlying conditions of things. I do not say that a mind may not possess both kinds of power, but the combination is rare. Still, a man at the worst can only fail, and a brilliant observer or analyst may prove himself to be a poor philosopher, and that is the worst result that can come. But this is not in reality the result of crossing the scientific frontier. If on the one side is God and on the other nature, this means that on the one side you have a moral and religious region, and on the other a purely physical region; and the passage from one to the other is quite certain to be fraught with danger, not to say mischief.

Let me illustrate my meaning by reference to a passage in Ernst Haeckel's "History of Creation."

"Creation," he writes, "as the *coming into existence of matter*, does not concern us here at all. This process, if indeed it ever took place, is completely beyond human comprehension, and can therefore never become the subject of scientific inquiry. Natural science teaches

* I have used this phraseology as expressing the difference between the *cause* and the *phenomena* of the material universe. Bacon writes, in the first aphorism of the second book of the "Novum Organum": "Datæ naturæ Formam, sive differentiam veram, sive naturam naturantem . . . invenire, opus et intentio est humanæ Scientiæ." But upon this Mr. Ellis remarks in a note: "This is the only passage in which I have met with the phrase *natura naturans* used as it is here. With the later schoolmen, as with Spinoza, it denotes God considered as the *causa immanens* of the universe, and therefore, according to the latter, not hypostatically distinct from it." As employed by me, the phrase is not intended (I need hardly say) to have any pantheistic tendency.

that matter is eternal and imperishable, for experience has never shown us that even the smallest particle of matter has come into existence or passed away. . . . Hence a naturalist can no more imagine the coming into existence of matter than he can imagine its disappearance, and he therefore looks upon the existing quantity of matter in the universe as a given fact. If any person feels the necessity of conceiving the coming into existence of this matter as the work of a supernatural creative power, of the creative force of something outside of matter, we have nothing to say against it. But we must remark that thereby not even the smallest advantage is gained for the scientific knowledge of nature. Such a conception of immaterial force, which at the first creates matter, is an article of faith which has nothing whatever to do with human science. *Where faith commences science ends.* Both these arts of the human mind must be strictly kept apart from each other. Faith has its origin in the poetic imagination; knowledge, on the other hand, originates in the reasoning intelligence of man. Science has to pluck the blessed fruits from the tree of knowledge, unconcerned whether these conquests trench upon the poetical imaginings of faith or not."*

With much which is contained in the preceding quotation I entirely agree. *Where faith commences, science ends;* this is perfectly true; but I miss any recognition of the truth that the supernatural power which most persons "feel the necessity of conceiving" is something much beyond a "creative force outside of matter." It is difficult, I think, for most of us to keep our minds clear of the conception of such force outside of matter, though I quite agree with the author that nothing is gained for the scientific knowledge of nature by adopting the conception. But what I think the mind feels chiefly the necessity of conceiving is the existence of a Being who is the ground of all the *moral* phenomena of the world; and, if a writer on natural history goes beyond his subject at all, he should recognize the fact that the passing of the boundary carries the mind into a region of moral philosophy and religion, and not merely into a speculation concerning the possible origination of matter.

That this criticism is not unfair and not unimportant may be, I think, concluded from the results to which Ernst Haeckel is himself led, and to which he wishes to lead his readers. He tells us that he has no fault to find with the hypothesis, if we feel it to be necessary, of an origin of matter; but he tells us subsequently that there is no purpose in nature, and no such thing as beneficence on the part of a Creator.

"Every one," he writes, "who makes a really close study of the organization and mode of life of the various animals and plants, and becomes familiar with the reciprocity or interaction of the phenomena of life, and the so-called 'economy of nature,' must necessarily come

* Vol. i., p. 8 (English translation).

to the conclusion that this 'purposiveness' no more exists than the much-talked-of 'beneficence' of the Creator. These optimistic views have, unfortunately, as little real foundation as the favorite phrase, 'moral order of the universe,' which is illustrated in an ironical way by the history of all nations. The dominion of 'moral' popes, and their pious Inquisition, in the mediæval times, is not less significant of this than the present prevailing militarism, with its 'moral' apparatus of needle-guns and other refined instruments of murder." *

This passage, as will be seen, takes us into the region of morals. There is no question here of permitting the hypothesis of an originating force outside of matter, if we feel such an hypothesis intellectually necessary; but we have instead a denial *ex cathedra* of the existence of such a thing as a moral order or of such a person as a beneficent Creator. This is not merely *atheous;* it is *atheistic.* An investigator of nature has a right to say that the question of the existence of a beneficent Creator or the non-existence of such a Being does not affect his investigations; but he has no right, upon the strength of investigations purely physical, to deny the existence of beneficence as an attribute of the Creator, if a Creator there be.

But I am not surprised to find utterance given to some expression of opinion as to the moral character of the Creator, when once the legitimate boundary of physical science has been transgressed. If a man can be satisfied with examining nature as he finds it, whether as an observer or as a mathematician, the question of a Creator need no more trouble him than it troubles the man who is busied with integrating equations or devising a new calculus; but if he is not satisfied with this, then he can scarcely stop short of a complete investigation of the whole question of theism; and the elements necessary to this complete investigation are certainly not to be found in physics, any more than you can find in physics the material for a complete treatise on poetry or music or painting.

For, in truth, physical science does not afford the basis even for a complete investigation of ourselves. When *anthropology* is classed among the physical sciences, it is necessary to confine the investigations comprehended under the title to the consideration of man as a creature having certain material attributes and leaving certain material marks of his existence in past ages: a study of the highest interest, and one which students have a right to call *anthropology,* if they please: but manifestly anthropology can not be translated by the words "the science of man," for the science of necessity leaves out of consideration all that is most interesting to man or which makes man most interesting.

To say that physical science does not include the study of man is perhaps nearly the same thing as saying that man is not a part of nature; and though such an assertion may seem paradoxical, there is

* Vol. i., p. 19.

a sense in which it is quite true, and it is important to observe what that sense is. Putting aside all questions of immortality, it is not difficult to conclude that mankind possess attributes which do not belong to other creatures, and which make it necessary, in examining the world, to put man in a class by himself.

Take a few examples. Let the first be that of will. The question is whether a human being has a command of his actions in a manner in which no other creature has. Simple experience seems to me to prove that he has: I do not feel that I need the help of philosophers to solve the question. A dog or a horse has in a certain sense a will, but I can calculate how a dog or a horse will act, if I know the conditions to which it is subjected; whereas I positively know from actual experience that I can do as I choose, independently of all external influences. Bring me to the test: tell me in any given circumstances what those circumstances will lead me to do, and I will undertake to do something different. And the power of will implies the capacity for self-sacrifice. Every animal is by its very nature selfish. Doubtless there are, in this as in other things, faint reflections of humanity in the humbler creatures, just as the στοργή of the animal, which lasts for a short time and utterly dies out when it has served its purpose, is the faint reflection of that human love which lasts through life and grows with years; but there is nothing in the life of animals which can be seriously named as being of the same kind as that feeling which inspired a Howard, or a Wilberforce, or a St. Vincent de Paul. The man who deliberately puts aside that which is most pleasant to men in general, and which he himself has every capacity to enjoy, and does something quite different from the dictates of his nature because he judges that something to be right or good, exhibits a quality and a power which is simply lacking in every other living creature except the human race.

Again, regard man as a being of purpose. I quoted a passage not long ago from Ernst Haeckel, in which he denies the existence of purpose in nature. Can purpose be denied to exist in man? If I am not mistaken, the whole history of civilization may be described as a development of purpose. Every other creature is apparently content with the condition in which it finds itself. Birds build nests as their ancestors did thousands of years ago; fishes have no ambition; possibly the time may have been when ants did not know the luxury of keeping aphis-cows, or being waited upon by slaves of their own race; but, speaking generally, it may be said that unprogressiveness marks all other animals, as distinctly as progressiveness does man. I put out of consideration, as not belonging to the argument, the question of evolution, and the progression of living things in that sense of the word. I am speaking only of nature as we see it now, and not as it may possibly once have been; and certainly, as things are now, it seems impossible to deny that while the animals about us are as fixed

in their habits and instincts as the plants, or nearly so, there is one race, namely, the human, which is not fixed at all, but is constantly devising something new, regarding nothing as gained while anything remains to be achieved.

Once more, take the more general attribute of thought. Much has been written of late concerning the minds of animals; it is a curious and interesting subject, and certainly I for one do not grudge our humbler friends in the great world-family of life any gift of mind with which they have been endowed. The brain of the ant is, as some one has truly said, perhaps the most wonderful little morsel of matter in existence. But certainly the mind of man is so incomparably more powerful and effective a machine of thought, that any comparison between it and the mind of the most gifted animal appears almost ridiculous. The fact is that our natural tendency is so much to assume the utter non-existence of mind in animals, that, when we find evidence of mind which we can not resist, we stand amazed at the discovery. In many things, as we know, the inferior creatures are much more clever than ourselves; we could never build a nest like a bird, or make a comb like a bee, or do ten thousand things which are being done every day by spiders and beetles. But still thought in the highest sense belongs to man. A dog sometimes looks as though he was thinking a thing out, and dog-stories are very wonderful; but, after all, the cleverest dog that ever lived yet has never been able to get beyond "Bow-wow," and we may safely predict that no dog will ever acquire even the simplest elements of human knowledge. I can not believe that this power of thought can properly be described as the mere result of phosphorus in the brain. That epigram, "*No phosphorus, no thought*," strikes me as having in it more of smartness than of wisdom. It is of course true that the brain is in some manner the organ of thought, and phosphorus may be the most important element in the formation of the brain; but is not thought conceivable independently of this particular machinery for making it possible to a material creature, just as motion is conceivable apart from horses or steam, or any of the causes to which it is commonly due? Is there not a kind of absurdity in regarding thought as the result of phosphorus, as real as if we should say, what upon the same principle of philosophy we might say, that truthfulness, kindness, modesty, were all functions of phosphorus? Nay, I do not know why we should not go further, and assert that there could be no thought without carbon or without any other element of which the human body is composed; for you can have no actual thought without a living creature, and no living creature without a body, and no body without carbon, ∴ etc.—Q. E. D.*

* I had not observed, when this was written, that the Archbishop of York had said nearly the same thing. "Without time, no thought; without oxygen, no thought; without water, no thought. All these are true, and they import a well-known fact, that man who thinks is a creature in a material world, and that certain forms of matter are need-

All these examples lead up to one sovereign attribute which comprehends and implies both them and others equally important, namely, the attribute of personality. A man can say, with a full sense of the meaning of what he says, not merely "I eat, drink, and sleep," nor even "I am conscious of will, purpose, and thought," but "I *am:* I am a conscious person, not a mere machine, though the proprietor of a wonderful piece of machinery. My body, my brain, my mind, are not merely things which work with a living innate power, but they are *mine*, they work for *me*, they do what *I* tell them. If they are out of order, I know it, and I complain of it; I say, for instance: 'I have overtasked my brain, I must give it some rest before I can do this or that; I know what I wish to do, and feel myself competent to do it, but my brain will not obey me because it is tired, just as my horse may be overworked, or as my knife will not cut when it has been blunted by too much use.'" So of the moral feelings. I can discuss them, I can guide my conduct by means of them, I can feel ashamed of this or that failure in upright or high conduct. A man knows that he is responsible for his actions. Sometimes a murderer is convicted twenty years after the offense has been committed, or he gives himself up after as many years because his memory and his conscience make his life intolerable. He has no doubt as to the fact that the person who did the deed of darkness years ago is the same person as he who feels the pangs of remorse to-day. Every material particle in his body may have changed since then; but there is a continuity in his spiritual being out of which he can not be argued, even if any ingenious sophist should attempt the task. No ingenuity will prevent the conscience-stricken murderer from pleading guilty.

There are, undeniably, anomalies of a very remarkable kind connected with the sense of personality, and cases are recorded in which men and women have had (as it were) a different personality at different times. An instance is recorded of a young woman who habitually passed from one state of existence or consciousness to another, so distinct that when in the second state she knew nothing of what had happened when she was in the first. For example, having returned upon one occasion from a funeral, she fell asleep, and awoke in a few moments in her second state; all remembrance of the funeral was gone, and she wondered why she was in mourning. This case appears to have been carefully and scientifically watched for many years, and to have given undeniable evidence of what may be described as a double existence or double consciousness; so that the being in question would have no true sense of personality, and certainly would not be admissible in a witness-box as evidence of any event said to have taken place.* Instances more or less of the same kind may probably be

ful to his existence as an organized being."—("Design in Nature," "Word, Work, and Will," p. 244.)

* I take this from the "Causeries Scientifiques," 1877 (Rothschild, Paris).

produced without limit. What they prove is, that we are dependent for the proper use of our faculties upon material conditions; the *corpus sanum* is one condition of the *mens sana;* but they do not prove the unreality of the attribute of personality any more than the existence of idiocy and insanity, or even the possibility of getting drunk and so losing all sense of who and what we are, prove it. Undoubtedly everything depends, in the case of a human being whose powers are exerted through material organs, upon the proper working condition of those organs, and a pressure of blood upon the brain may make a man of the holiest life and the most philosophical temper commit suicide, as experience proves. But all such morbid exceptions to the general rule can not destroy the belief which a man in his normal condition feels compelled by the conditions of his existence to hold, namely, that he is himself and no one else, that he is responsible for his actions, and that what he does now will bear fruit in his subsequent experience either for good or for evil, unless he becomes deranged. The author from whom I have taken the above case of double personality exclaims very naïvely: "Ah! comme il faut avoir un peu de saine complaisance pour les sept péchés capitaux! Jugez: un peu de sang de trop, peut-être un centième de gramme mal dirigé au contact d'une pauvre petite résille de nerfs, et le voilà fait, l'orgueilleux, le vaniteux, le superbe!" True: we must be cautious in forming opinions of actions; and in any human court—we may believe also in the court divine—every circumstance connected with an action must be taken into account in order that a just judgment of it may be formed; but all this does not prove that there is no such thing as haughtiness, or vanity, or pride, or that sane men are not responsible for their temper of mind and the quality of their actions.

To come back, then, to the conception of personality. I can not but feel sure that this is the highest conception that I can possess of my own being, or of any kind of being. All history seems to transmute itself into a kind of phantasmagoria or illusive pantomime, unless the attribute of personality be conceded to the actors. Socrates, Alexander, Julius Cæsar, Cromwell, Napoleon, must be studied without reference to phosphorus, and upon principles lying altogether outside the territory of physical science. And this postulate of personality seems to me to lead, by an intellectual necessity, to the conception of personality in a region not of φωσφόρος, but of Φῶς itself, the conception of *the Person*, ὁ ὤν, of whom persons like ourselves are, as it were, a faint reflection.

The study of the being and doings of this Person would seem to be of necessity one of the most interesting that can be suggested to the mind of man. The study may be conducted upon different, though not crossing, lines; the chief lines being the physical, the metaphysical or philosophical, the moral, the religious. Each of these branches has its own method and its own sources of illumination; each also has

its own peculiar difficulties and its own anomalies and contradictions. A really complete scientific theism, such a theism as Bacon would have delighted to map out in detail, would comprehend all the different departments of which I have spoken, and in the unity of such a system physicists and philosophers and divines would be able to meet and shake hands.

It is a curious subject of inquiry, and the reader will, I think, pardon me for here introducing it, how far, upon the theistic view of nature, we can discriminate between that which is necessary in the nature of things and that which is to be regarded as being such as it is in virtue of a divine purpose or choice. It seems clear, for example, that when once matter is assumed to be the subject of a divine operation, as in the case of the universe with which we are acquainted and of which we form a part, certain necessary conditions are imposed upon the creative work or upon the system of nature. These conditions may be, in a certain sense, limitations of divine power; but they are not limitations in any more objectionable sense than are the truths of geometry or number, to which all created things must be conformable. Sometimes a condition of this kind exists which is not at all obvious at first sight, and which, nevertheless, is as necessary to be taken into account as the truth that two and two make four and can not make five. Thus, for example, Laplace suggests that the utility of the moon is not as great as it might have been, and he points out an arrangement according to which, as he shows, the earth would have received much more light than it actually does; but I remember having read a memoir by Liouville in one of the numbers of his "Journal," in which he shows that the arrangement proposed by Laplace would not be *stable*—that is, that it would only be possible in the sense in which it is possible to make a pin stand upon its point. An example of this kind shows the necessity of caution in any suggestions which may be made for the improvement of natural arrangements. But it does more than this; it helps to illustrate the point which I am now endeavoring to discuss, with reference rather to the philosophy of the arrangements which we see than to any suggestions for improving them.

Let us consider for a moment what is called by mathematicians the *principle of least action*. Putting this principle into popular language, it may be described as asserting that the motion of bodies generally takes place in such a manner that the energy expended in the motion is the least possible. From this principle, when enunciated in a strict mathematical form, the equations of motion of a system may be deduced, or, in other words, the problem of the motion of a system may be solved. The remarkable fact connected with this principle is, that its truth was evolved by a speculative mind out of the general principle that nature would use the least effort possible to produce a given result, before it was demonstrated in its strict form by

mathematicians; and, looking upon it thus, we should be disposed to regard the form of motion which involves least effort as being chosen out of all possible forms, much in the same way as a man who has to perform a journey or to do a certain piece of work inquires how the journey or piece of work can be reduced to a minimum of trouble or expense. But the fact of the "principle of least action" being mathematically deducible from the principles of motion would seem to prove that there is in reality no choice in the matter, but that *least action* is as necessary a truth as is that of the least distance between two points on a sphere being that which is traced by the great circle joining them.

Just consider this question of two points on a sphere. As a matter of geometry it is easy to show that the shortest path between them is that given by the great circle, and this principle is now well recognized in navigation. But change the problem from geometry to dynamics, by supposing a particle to move on the surface of a smooth sphere under the action of a force tending to the center, as that exerted by an elastic string in a state of tension; then it is equally easy to prove that this particle, when started in any direction, will describe a great circle—that is, its motion will be such that the distance traversed by it in passing from its point of departure to any point in its path will be the shortest distance between those points. It might be said that the particle *chose* the easiest path, but in reality there was no choice, nothing but necessity; in other words, the dynamical minimum stands on the same footing as the geometrical.

In truth, the question of *minimum* comes under our notice very frequently and very curiously in nature. The path of a ray of reflected light may be determined upon the principle that it is the shortest possible; and this is not the only case in which the law of minimum is illustrated by optics. But take a very different case, that of the cells made by the bee. It is well known that the bee is a wonderful geometer. The cells consist of hexagonal prisms closed at the ends with three tiles having exactly the angles which with a given amount of material will make the cells most capacious, or with a given capacity will use the smallest amount of material. This has been long known, and has given rise to much speculation as to the manner in which the bee is guided to so remarkable a result. I am not aware that any satisfactory solution has yet been proposed; but the intellectual conception of the problem is much simplified if we bear in mind that the transverse section is the nearest form possible to a circle, and the form of the end of the cell the nearest possible to a sphere; so that it may be said that the instinct of making circular prismatic cells with spherical ends, and then clearing away unnecessary wax, is all the instinct which the bee requires. Let the reader observe that this is said, not with a view to depreciate the bee's architectural skill, but only for the

purpose of pointing out that the application of the wax in the most economical manner, making it go as far as possible, subject to the condition of forming prismatic cells, is a geometrical result from adopting the simplest plane and solid figures, namely, the circle and the sphere. Let me illustrate this by a single example. Suppose I gave a coppersmith a lump of copper, and said, "Make this into a bowl of given thickness, having a maximum of capacity"; my coppersmith would undoubtedly be posed. But suppose I said, "Make this into as simple a bowl as you can, and let the material be of such a thickness": he would almost certainly make it hemispherical, or nearly so, because that is the simplest form; but his hemispherical bowl would, as a matter of fact, possess the property of maximum content which I wished it to have.

It seems to me, therefore, that there may be not a few cases in which arrangements, that appear at first sight to be the result of a choice among many that might be possible, are in fact arrangements which are necessitated by geometrical conditions, or what may be equivalent to them. This consideration should make us cautious in attributing to an arbitrary will facts which might seem at first sight to warrant this conclusion. Then, again, there are phenomena in the ordinary functions of nature, having the appearance of chance, which yet are not chance in the true sense of the word, but which have strongly the appearance of it, and for which it is difficult to give any account. The manner in which plants turn toward the light is to me a profound mystery; there must be a force to produce the motion, but I do not perceive whence it can arise. And the instinct of seeking the light sometimes assumes the most wonderful form. I think I have read of a potato in a dark cellar throwing out a long sprout which extended itself till it emerged at a hole at a distance through which light entered. The power which living matter has to adapt itself to unforeseen circumstances, of which this potato may be taken as a humble instance, has very much of the appearance of choice. A limb is broken, or a skull is trepanned, and the limb becomes as strong as ever, and the skull retains whatever brain it may have had within it, in virtue of new efforts of nature exactly adapted to the wants; but these wants are such as could not have been foreseen, and could scarcely have been included in the original idea, so to speak, of the man to whom the accident has happened.

Therefore I feel that we are on very difficult and mysterious ground when discussing the place which should be assigned in nature to *choice*. I think that we ought to recognize the fact that many things in the edifice of nature, which might strike us at first sight as the arbitrary touches of the great Architect, may in reality be the results of geometrical or other necessity inherent in the conditions of space, or time, or matter. Nevertheless, it is difficult to believe that a creation such as we see round about us, and of which we form a part, could have

been evolved out of its primitive elements without the exercise of that which, for want of a better word, I will call choice. Why should our hearts be on the left side rather than on the right? Why should we have five digits rather than seven? Why should we have one thumb rather than two? Why, to take a larger instance, should the planets be exactly such as they are in size and in other conditions, which apparently follow no law whatever? Why should the exact quantity of matter exist which does exist, for an infinite quantity is, I suppose, inconceivable? And what determines the precise pace at which all the bodies which constitute the universe move? To use the language of a mathematician, what determines all the arbitrary constants and arbitrary functions in the integrals of nature's equations? This string of questions might be lengthened indefinitely, but the reader will see what the force of them is. If the principle of symmetry could be asserted concerning the human body or concerning the solar system, that symmetry might answer many questions; it might be said, "This or that is so, because there is no reason why it should be otherwise." But there is an absence of symmetry from many parts of nature, and, when no geometrical or other cause can be assigned, you need the hypothesis of an independent will in order to render the irregular formation in any degree intelligible. A supreme will throws light upon the darkness; it may leave some difficulties unsolved, but we feel that in it we have got the key.

But my pen has run as far as perhaps my readers will care to follow me; and I conclude, therefore, by reminding them of the thesis which my essay has been intended to illustrate. It is the relation of God and nature, and the connection between the study of the latter and the knowledge of the former. I would say at the end what I said at the beginning, that physical science is properly and necessarily *atheous*, but not properly and not necessarily *atheistic*. Clerk Maxwell, that great intellect, whom Cambridge and the world have recently lost, was no atheist, but a devout believer in God; yet no man had penetrated more deeply and more successfully into the arcana of matter, and discussed more profoundly and more ingeniously the molecules of which the universe is made. Is this wonderful? I think not. It seems to me that, while it is the duty of a scientific inquirer, as such, to exclude from his inquiries anything that at all transcends the natural region, and therefore God can have no place in his inquiries, yet the moral effect of the discipline of investigation ought to be, in the case of a well-balanced mind, to compel it, if need be, to "cross the boundary of experimental evidence" and recognize the existence of Him "who hath created all things," in whom "we live, and move, and have our being."—*Nineteenth Century.*

THE BUFFALO AND HIS FATE.

By ERNEST INGERSOLL.

PERHAPS no indigenous animal of this country has attracted more attention or met with a greater number of biographers than the bison or buffalo. Its history has been a tale of extermination, and a very few years are likely to see the last of these noble beasts roaming over the Plains. For hundreds of years the few that remain of the herds of aurochs, the European bison, have been kept in the parks of the nobility; but, in this "free" country, not even this means of safety seems left to our persecuted buffalo.

To the Spanish colonists the American bison was commonly known under the name of *cibola*, while the French usually called it *le bœuf*, *buffle*, *vache sauvage*, or *bison d'Amérique*. Peter Kalm, who traveled through America in 1749, spoke of them as *wilde ochsen* and *kühe*. But the word *buffalo*—at first spelled *buffelo*—soon replaced the earlier names. Scientific men claim that our species (*Bison Americanus*, Smith) should be called bison, as buffalo is applicable only to the East Indian genus *Bubalus*.

It appears that our bison has already outlived at least two other races, which exceeded it in size—the *Bison latifrons* and the *Bison antiquus*. The former was contemporary with the mastodon, and was an ox of gigantic bulk, the tips of whose horns were eleven or twelve feet apart, and which probably stood as high as an elephant. Of the latter species more abundant remains have been dug up, particularly from the ice-cliffs at Escholtz Bay, on the Arctic coast north of Alaska. This fossil ox was of smaller size than the *Bison latifrons*, but much larger than the existing buffalo, although not greatly different from it in form. It seems to have been spread over the northwestern half of the continent from the Ohio Valley to Alaska, and everywhere its remains occur with those of the larger extinct mammalia, yet it may have survived to a comparatively recent date.

With the appearance of the buffalo, which only a few decades ago swarmed in prodigious herds over nearly a third of North America, all are familiar. The male measures about nine feet from the muzzle to the insertion of the tail; the female about six and a half feet. The height to the top of the hump of the male is five and a half to six feet, and of the female about five feet, sloping in each case to a height at the hips of four and a half to four feet. The weight of the old males is nearly two thousand pounds, while the cows weigh one thousand to twelve hundred pounds. The horns are short, thick at the base, curved, and sharply pointed; the hoofs are short and broad; the short tail ends in a tuft of long hairs. In winter the head and whole under parts are blackish-brown; the upper surface lighter, fading as spring advances.

Young animals are of a darker, richer brown than the old ones, age bleaching the thick masses of long, woolly hair, which falls so abundantly over the shoulders and face, to a light yellowish-brown. In the spring the hinder parts are almost naked through the molting of the hair, while that upon the shaggy fore parts remains permanently. Pied coats are occasionally met, and examination and measurements of skulls and skeletons show much individual variation in form and proportions.

In Mr. J. A. Allen's recent book * upon "The Bison, Past and Present, in this Country," which is one of the most complete and admirable monographs ever written on any subject, and from which I derive my facts, an extended account of the animal's history and habits is given.

As is well known, the buffalo is preëminently gregarious—herds numbering millions of individuals, and blackening the whole landscape, having formerly been met with constantly on the Plains. Emigrant trains used to be delayed by the passing of dense herds, and during the first years of the Kansas Pacific railway its trains were frequently stopped by the same cause. These masses seem to have some sort of organization, consisting of small bands which unite in migration or when pursued, but separate when feeding. The cows, with their calves and the younger animals, are generally toward the middle of the small herd, while the older bulls are found on the outside, and the patriarchs of the herd bring up the rear. Much romancing has been wasted on this simple and natural grouping by writers who have described the supposed regularity and almost military precision of their movements. The sluggish, partly disabled old males constitute the "lordly sentinels" of such tales, who are supposed to watch with fatherly care over the welfare of their "harems." The truth is that these protectors, fancied so alert, are the most easily approached of any of the flock, and the real guardians are the vigilant cows themselves, who usually lead the movements of the herd.

The rutting-season is July and August. The period of pregnancy is nine months, and rarely more than a single calf is born, which follows the mother for a year or more. During the rutting-season the bulls wage fierce battles, but they rarely result fatally. The short horns are not very dangerous weapons, and the masses of hair on the forehead break the force of the stunning collisions. At this season the bulls become lean, regaining their flesh in autumn, while the cows are fattest in June. During its molting in midsummer the animal possesses a very ragged and uncouth appearance, the hair hanging here and there in matted, loosened patches, with intervening naked spaces; and it endeavors to free itself from this loosened hair, by rubbing

* Volume I., Part II., "Memoirs of the Geological Survey of Kentucky," Professor N. S. Shaler, Geologist, in charge; and reprinted by the Museum of Comparative Zoölogy as one of its "Memoirs." Cambridge, 1875.

against rocks and trees, or rolling on the ground. Their coats are in prime condition for robes in December.

The buffalo is nomadic in its habits, roaming in the course of the year over vast areas in search of food or safety. The fires that annually sweep across thousands of square miles of the grassy plains, the ravages of grasshoppers, often destroying equally extensive tracts of vegetation, and the habit of keeping in compact herds, which soon exhaust the herbage of a single region, all compel constant movement. There is a popular belief that the buffaloes used to migrate from the northern plains to Texas in fall and back again in spring, but this seems erroneous. Before the intersection of the West by railroads and emigrant trails their movements were more regular, no doubt, than at present, and slight northward and southward migrations are well attested as occurring in Texas and also on the Saskatchewan plains; but the herds constantly winter as far north as the latter region, and for twenty-five years have not passed southward even to the Platte. In the extreme north they leave the exposed plains in winter and take shelter among the wooded hills. Such local movements as these were formerly very regular, and hunters knew just where to look for their game at any season of the year.

The behavior of the buffaloes is very much like that of domestic cattle, but their speed and endurance seem to be far greater. When well under way it takes a fleet horse to overtake them, and they raise a column of dust which marks their progress when miles away. They swim rivers with ease, even amid floating ice, and show a surprising agility and expertness in making their way down precipitous cliffs and banks of streams, plunging headlong where a man would pick his way with hesitation. Ordinarily, however, the buffalo exhibits commendable sagacity in his choice of routes, usually taking the easiest grades and the most direct course, so that a buffalo-trail—often worn deep into the ground—can be depended on as affording the most feasible road through the region it traverses.

When belligerent, the old bulls make the most blustering demonstrations, but are really cowardly. Facing the approaching hunter with a boastful and defiant air, they will pace to and fro, threateningly pawing the earth, only to take to their heels the next moment. The bulls greatly enjoy pawing the earth and throwing it up with their horns, digging into banks or getting down upon one knee to strike into the level surface, so that the sheaths of their horns are always badly splintered. They are very fond, too, of rubbing themselves, and evidently regard the telegraph-poles along the railroads as set there for their especial convenience in this respect. But their chief delight is in "wallowing." Finding in the low parts of the prairie a little stagnant water among the grass, or at least the surface soft and moist, an old bull plunges his horns into the ground, tearing up the earth and soon making an excavation into which the water trickles,

forming for a short time a cool and comfortable bath, in which he wallows like a hog in the mire, swinging himself round and round on his side, and thus enlarging the pool until he is nearly immersed. At length he rises besmeared with a coating of mud, which, drying, insures him immunity from insect pests for many hours. Others follow, each enlarging the "wallow" until it becomes twenty feet in diameter, remains a prominent feature in the landscape, and forms a cistern where a grateful supply of water is often long retained for the thirsty denizens of that dry region.

Like the other species of the bovine group the bison is of a sluggish disposition, and mild and timid, ferocious as his shaggy head and vicious eye make him look. He rarely attacks, except in the last hopeless effort of self-defense. "Endowed with the smallest possible amount of instinct," says Colonel R. I. Dodge, "the little he has seems adapted rather for getting him into difficulties than out of them. If not alarmed at sight or smell of a foe, he will stand stupidly gazing at his companions in their death-throes until the whole herd is shot down. He will walk unconsciously into a quicksand or quagmire already choked with struggling, dying victims." Having made up his mind to go a certain way, it is almost impossible to swerve him from his purpose, and he will rush heedless into sure destruction. Two trains were "ditched" in one week on the Atchison, Topeka and Santa Fe Railroad by herds of buffaloes rushing blindly against and in front of them. Finally the conductors "got the idea," and gave the original occupants of the soil the right of way whenever they asked it. During a voyage down the upper Missouri in 1877, our steamer more than once had to stop to allow swimming herds to get out of the way, and once we completely keel-hauled a sorry old bull. Yet, as Mr. Allen suggests, their inertness may be exaggerated by writers, as their sagacity certainly has been. This stupidity, unwariness, or liability to demoralizing panic, places them at the mercy of the hunter, who is their only enemy besides the wolves. In former times, young or weak animals straying from the herds, and all the wounded and aged that could be separated from their fellows, were quickly set upon and worried to death by wolves; but now these brutes have become so reduced as not to form a serious check upon their increase.

The early explorers of the Mississippi Valley believed that the buffalo might be made to take the place of the domestic ox in agricultural pursuits, and at the same time yield a fleece of wool equal in quality to that of the sheep; but no persistent attempts have yet been made to utilize it by domestication. That the buffalo-calf may be easily reared and thoroughly tamed has been conclusively proved, but little attention has been paid to their reproduction in confinement, or to training them to labor. During the last century they were domesticated in various parts of the colonies, and interbred with domestic cows, producing a half-breed race which is fertile, and which readily amalgamates

with the domestic cattle. The half-breeds are large, fine animals, possessing most of the characteristics of their wild parentage. They can be broken to the yoke, but are not so sober and manageable in their work as the tame breed—sometimes, for instance, making a dash for the nearest water, with disastrous results to the load they are drawing. It is somewhat difficult, also, to make a fence which shall resist the destructive strength of their head and horns. But the efforts at taming buffaloes have not been many or seriously carried on, and no attempt appears to have been made to perpetuate an unmixed domestic race. Probably after a few generations they would lose their natural untractableness, and when castrated would doubtless form superior working-cattle, from their greater size, strength, and natural agility.

"The fate of extermination so surely awaits, sooner or later, the buffalo in its wild state, that its domestication becomes a matter of great interest, and is well worthy the attention of intelligent stock-growers, some of whom should be willing to take a little trouble to perpetuate the pure race in a domestic state. The attempt can be hardly regarded otherwise than as an enterprise that would eventually yield a satisfactory and profitable result, with the possibility of adding another valuable domestic animal to those we now possess."

The precise limit of the range of the buffalo when the first Europeans visited America is still a matter of uncertainty, yet its boundaries at that time can be established with tolerable exactness. It was beyond doubt almost exclusively an animal of the prairies and the woodless plains, ranging only to a limited extent into the forested districts east of the Mississippi River. The results of the present exhaustive inquiries seem to show that its extension to the northward, east of the Mississippi, was limited by the Great Lakes. Contrary to the supposition of several recent writers, Mr. Allen has not been able to find a single mention of its occurrence within the present limits of Canada, New England, or New York State, although the name of the city of Buffalo and the neighboring "Buffalo Creek" probably imply that this animal once extended its travels to that point. All the supposed references to its being seen on the St. Lawrence, or in Canada West, turn out to mean the elk—the same indefinite terms being often used for both by early writers—or else to apply to some part of the broad territory then called Canada, but not now included within its limits. Changes in political boundaries have constantly to be borne in mind in studying ancient narratives.

Furthermore, no remains of the bison have been found among the bones in the shell-heaps along the Atlantic coast, and there is no unquestionable evidence, among all the early lists of the natural products of the country, of its occurrence anywhere on the seaboard north of the Potomac for a long period antedating the discovery of the continent by Europeans. The only well-authenticated instances of its being found east of the Blue Ridge are the apparently casual passage

of small herds through the mountains from West Virginia into the upper parts of North and South Carolina by way of the New, Holston, and French Broad Rivers. They seem to have been common on the savannas about the heads of the rivers in the western parts of those States; but it is well attested that they never came down to the sea-coast. Nor can good evidence be shown that they ever reached any part of Georgia, Florida, or Alabama (although possibly Mississippi), as at present bounded, not appearing habitually to have penetrated south of the Tennessee River—unless just along the bank of the Father of Waters—on account of the thickness of the forest.

The records in general then show, that at the beginning of the seventeenth century the range of the buffalo east of the Mississippi, with the exception of its occasional appearance on the eastern slope of the Alleghanies in the Carolinas and Virginia, was restricted to the area drained by the Ohio River—except over the lowlands at its mouth—and to the eastern tributaries of the Mississippi in northern Wisconsin and Minnesota; also that it was very numerous and uniformly distributed over the prairies of Illinois and Indiana, and also about the upper tributaries of the Ohio, but less numerously and uniformly over Ohio, West Virginia, Kentucky, western Pennsylvania, and the northern portion of Tennessee, being everywhere restricted to the prairies and scantily wooded land along the streams.

In the appendix Professor Shaler offers a short discussion of the probable age of the bison in the Ohio Valley. In the swamps surrounding the "salt-licks" of Kentucky buffalo-bones are found packed in great quantities in the mucky soil, but only about the latest vents of the saline waters, which have from time to time changed their points of escape from the ground. The caverns of Kentucky and Tennessee, which were the homes of the aboriginal people of the region, and receptacles for their dead, and where have been found skeletons of the beaver, deer, wolf, bear, and many other mammals, have never yielded any bones of the bison. Moreover, among all the many figures of animals and birds found on the pottery and ornaments of the prehistoric races of the West, the marked form of the buffalo does not appear, making it presumable that this animal was unknown to the people who built the mounds. Professor Shaler is of the opinion, held by many ethnologists, that the "mound-builders" were essentially related to the Natchez group of Indians, and were driven southward by ruder tribes of red-men from the north and northwest. The Indians north of the Ohio are known to have been much in the habit of burning the forests, and no doubt the invaders alluded to above signalized their advance by such conflagrations. This making of plains by the repeated burning of forests, aided by "the continued decrease of the rainfall, which was "a concomitant of the disappearance of the glacial period," permitted the buffalo to advance rapidly eastward as far as the Alleghanies, and, coincidently, as far as the mound-building people appear

to have settled the country. Its advent thus seems to have been singularly recent.

The question of the origin of the buffalo and its relation to the earliest tribes of people in the Ohio Valley is made still more complicated by the fact that an earlier and closely related species of buffalo, probably coeval with the mammoth and musk-ox, and possibly with the caribou and elk, was living at the time just following the close of the glacial epoch. "I am strongly disposed to think," writes Professor Shaler, "that in the *Bison Americanus* we have the descendant of the *Bison latifrons*, modified by existence in the new conditions of soil and climate to which it was driven by the great changes closing the last ice age." But he adds that future explorations will probably show that there was an interval of some thousands of years between the two species along the Ohio.

Although the main chain of the Rocky Mountains has been supposed commonly to form the western limit of the range of the buffalo, there is abundant proof of its former existence over a vast area west of it, including a large part of the Utah Basin, the Green River plateau, and the plains of the Columbia, westward to the Blue Mountains of Oregon, and the Sierra Nevada. Evidence of this is found in the bleached skulls, in accounts of early explorers, and in traditions of the Indians. During the very severe and snowy winter of 1836–'37 large herds were lost through starvation; by 1840 they had retreated eastward to the forks of the Yellowstone and been extirpated in the Utah Valley and about the head-waters of the Colorado; and ten years later were never to be found west of the Rocky Mountains, between the British possessions and the Rio Grande del Norte. Westward of this great river it does not seem, within the past two centuries, to have extended itself at all into the highlands of New Mexico; but, farther south, there is proof of its former range over the northeastern provinces of Mexico to at least the twenty-fifth parallel, though it was never abundant there, and abandoned that region before the beginning of the current century.

The great center of buffalo-life in ages past was the vast expanse of treeless plains which stretch uninterruptedly from the Texas coasts almost to the Arctic Circle, and here, in restricted areas, they have survived until the present time.

When Cabeça de Vaca met them in 1530 they ranged throughout nearly the whole of Texas, the higher prairie-lands of northwestern Louisiana and Arkansas, and thence uniformly northward and westward. But soon after 1820 they disappeared altogether from Arkansas, and were not seen in western Missouri and southern Iowa later than 1825; but immense herds still roamed over the northern half of the latter State. Since 1845, however, few have been seen anywhere within Iowa, nor did they linger many years longer in Minnesota.

The stream of emigration across the plains to California about 1859

had a curious and permanent effect on the buffaloes. The overland route followed up the Kansas and Platte Rivers, and thence westward by the North Platte to the South Pass. The buffaloes were soon all driven from this line of travel; and the great herd which had stretched from the Rio Grande to the Saskatchewan was permanently divided into two—a northern and a southern herd—which were more and more widely separated by the construction of the Union Pacific Railroad. Year by year since, the limits of the range of each division have been contracting under relentless persecution and the encroachments of civilization, until now they are easily circumscribed. The poor beasts have been hunted by the Indians, have been followed incessantly by white men—professional hunters, sportsmen, hide-seekers, and soldiers—who have been afforded easy access to their haunts by the railroads which have penetrated to their ancient pastures, and been given the means of keeping up the hunt by the nearness of the frontier settlements to the resorts of each herd. Enormous destruction has ensued in Kansas and Colorado, and has had the effect to drive the southern division southward and southwestward into Texas, where hunters can not or (on account of Indians) dare not follow them. They are, therefore, just now (1876) afforded temporary rest from persecution; but, unless legal interference be quickly made and strict regulations rigorously enforced, the fate of the buffalo south of the Platte will be a repetition of its history east of the Mississippi—speedy extermination.

As to the northern herd, while twenty years ago buffaloes were accustomed to frequent the whole region between the Missouri River and the forty-ninth parallel, from the western boundary of Dakota to the Rocky Mountains, and even far into their valleys, they are now restricted to the comparatively small area drained by the southern tributaries of the Yellowstone, and northward over the most of Montana to the Missouri. North of the Missouri River almost a separate subdivision of the herd seems to exist, which feeds between longitude 106° and the Rocky Mountains, and northward to the wooded region of the Athabasca and Peace Rivers. Within thirty years they have become extirpated over half of this fertile region north of our boundary, and their numbers, probably, have correspondingly decreased.

It thus appears that in three quarters of a century the buffalo has been compelled to relinquish a habitat, covering a third of the continent, for two regions not greater together than the present Territories of Montana and Dakota; and they were formerly just as numerous over the whole extent as they now are in favored spots within their range. Hence the theory that they have not been so much reduced in numbers, as they have been circumscribed in range and concentrated upon narrow limits, will not hold good. Over much of this great region they were actually killed on the spot, not driven out.

SHAM ADMIRATION IN LITERATURE.

By JAMES PAYN.

IN all highly civilized communities Pretense is prominent, and sooner or later invades the regions of Literature. In the beginning, this is not altogether to be reprobated; it is the rude homage which Ignorance, conscious of its disgrace, offers to Learning; but after a while, Pretense becomes systematized, gathers strength from numbers and impunity, and rears its head in such a manner as to suggest it has some body and substance belonging to it. In England, literary pretense is more universal than elsewhere from our method of education. When young gentlemen from ten to sixteen are set to study poetry (a subject for which not one in a hundred has the least taste or capability even when he reads it in his own language) in Greek and Latin authors, it is only a natural consequence that their views upon it should be slightly artificial. The youth who objected to the alphabet that it seemed hardly worth while to have gone through so much to have acquired so little, was exceptionally sagacious; the more ordinary lad conceives that what has cost him so much time and trouble, and entailed so many pains and penalties, must needs have something in it, though it has never met his eye. Hence arises our public opinion upon the ancient classics, which I am afraid is somewhat different from (what painters term) the private view. If you take the ordinary admirer of Æschylus, for example—not the scholar, but the man who has had what he believes to be "a liberal education"—and appeal to his opinion upon some passage in a British dramatist, say Shakespeare, it is ten to one that he shows not only ignorance of the author (the odds are twenty to one about *that*), but utter inability to grasp the point in question; it is too deep for him, and especially too subtile. If you are cruel enough to press him, he will unconsciously betray the fact that he has never felt a line of poetry in his life. He honestly believes that the "Seven against Thebes" is one of the greatest works that ever was written, just as a child believes the same of the "Seven Champions of Christendom." A great wit once observed, when bored by the praises of a man who spoke six languages, that he had known a man to speak a dozen, and yet not say a word worth hearing in any one of them. The humor of the remark, as sometimes happens, has caused its wisdom to be underrated; for the fact is that, in very many cases, all the intelligence of which a mind is capable is expended upon the mere acquisition of a foreign language. As to getting anything out of it in the way of ideas, and especially of poetical ones, that is almost never attained. There are, indeed, many who have a special facility for languages, but in their case (with a few exceptions) one may say without uncharity that the acquisition of ideas

is not their object, though if they did acquire them they would probably be new ones. The majority of us, however, have much difficulty in surmounting the obstacle of an alien tongue, and when we have done so we are naturally inclined to overrate the advantages thus attained. Every one knows the poor creature who quotes French on all occasions with a certain stress on the accent, designed to arouse a doubt in his hearers as to whether he was not actually born in Paris. *He*, of course, is a low specimen of the class in question, but almost all of us derive a certain intellectual gratification from the mastery of another language, and as we gradually attain to it, whenever we find a meaning we are apt to mistake it for a beauty.* Nay, I am convinced that many admire this or that (even) British poet from the fact that here and there his meaning has gleamed upon them with all the charm that accompanies unexpectedness.

Since classical learning is compulsory with us, this bastard admiration is much more often excited with respect to the Greek and Latin poets. Men may not only go through the whole curriculum of a university education, but take high honors in it, without the least intellectual advantage beyond the acquisition of a few quotations. This is not, of course (good heavens !), because the classics have nothing to teach us in the way of poetical ideas, but simply because to the ordinary mind the acquisition of a poetical idea is very difficult, and when conveyed in a foreign language is impossible. If the same student had given the same time—a monstrous thought, of course, but not impracticable—to the cultivation of Shakespeare and the old dramatists, or even to the more modern English poets and thinkers, he would certainly have got more out of them, though he would have missed the delicate suggestiveness of the Greek aorist and the exquisite subtilties of the particle *de*. Having acquired these last, however, and not for nothing, it is not surprising that he should esteem them very highly, and, being unable to popularize them at dinner-parties and the like, he falls back upon praise of the classics generally.

Such are the circumstances which, more particularly in this country, have led to a wellnigh universal habit of literary lying—of a pretense of admiration for certain works of which in reality we know very little, and for which, if we knew more, we should perhaps care less.

There are certain books which are standard, and as it were planted in the British soil, before which the great majority of us bow the knee and doff the cap with a reverence that, in its ignorance, reminds one of fetich-worship, and, in its affectation, of the passion for high

* Since the above was written, my attention has been called to the following remark of De Quincey: "As must ever be the case with readers not sufficiently masters of a language to bring the true pretensions of a work to any test of feeling, they are for ever mistaking for some pleasure conferred by the writer, what is in fact the pleasure naturally attached to the sense of a difficulty overcome."

art. The works without which, we are told at book-auctions, "no gentleman's library can be considered complete," are especially the objects of this adoration. The "Rambler," for example, is one of them. I was once shut up for a week of snow-storms in a mountain inn, with the "Rambler" and one other publication. The latter was a "Shepherd's Guide," with illustrations of the way in which sheep are marked by their various owners for the purpose of identification: "Cropped near ear, upper key bitted far, a pop on the head and another at the tail head, ritted, and with two red strokes down both shoulders," etc. It was monotonous, but I confess that there were times when I felt it some comfort in having that picture-book to fall back upon, to alternate with the "Rambler."

The essay, like port wine, I have noticed, requires age for its due appreciation. Leigh Hunt's "Indicator" comprises some admirable essays, but the general public have not a word to say for them; it may be urged that that is because they had not read the "Indicator." But why, then, do they praise the "Rambler" and Montaigne? That comforting word, "Mesopotamia," which has been so often alluded to in religious matters, has many a parallel in profane literature.

A good deal of this mock worship is of course due to abject cowardice. A man who says he doesn't like the "Rambler" runs, with some folks, the risk of being thought a fool; but he is sure to be thought that, for something or another, under any circumstances; and, at all events, why should he not content himself, when the "Rambler" is belauded, with holding his tongue and smiling acquiescence? It must be conceded that there are a few persons who really have read the "Rambler," a work, of course, I am merely using as a type of its class. In their young days it was used as a school-book, and thought necessary as a part of polite education; and, as they have read little or nothing since, it is only reasonable that they should stick to their colors. Indeed, the French satirist's boast that he could predicate the views of any man with regard to both worlds, if he were only supplied with the simple data of his age and his income, is quite true in the general with regard to literary taste. Given the age of the ordinary individual—that is to say of the gentleman "fond of books, but who has really no time for reading"—and it is easy enough to guess his literary idols. They are the gods of his youth, and, whether he has been "suckled in a creed outworn" or not, he knows no other. These persons, however, rarely give their opinion about literary matters, except on compulsion; they are harmless and truthful. The tendency of society in general, on the other hand, is not only to praise the "Rambler" which they have not read, but to express a noble scorn for those who have read it and don't like it.

I remember, as a young man, being greatly struck by the independence of character exhibited by Miss Brontë in a certain confession she made in respect to Miss Austen's novels. It was at a period when

everybody professed to adore them, and especially the great guns of literature. Walter Scott thought more highly of the genius of the author of "Mansfield Park" even than of that of his favorite, Miss Edgeworth. Macaulay speaks of her as though she were the Eclipse of novelists—"first and the rest nowhere"—though his opinion, it is true, lost something of its force from the contempt he expressed for "the rest," among whom were some much better ones. Dr. Whewell, a very different type of mind, had "Mansfield Park," I believe, read to him on his death-bed. And, indeed, up to the present date, some highly cultured persons of my acquaintance take the same view. They may be very possibly right, but that is no reason why the people who have never read Miss Austen's novels—and very few have—should ape the fashion. Now, the authoress of "Jane Eyre" did not derive much pleasure from the perusal of the works of the other Jane. "I know it's very wrong," she modestly said, "but the fact is I can't read them. They have not got story enough in them to engage my attention. I don't want my blood curdled, but I like it stirred. She strikes me as milk-and-watery, and, to say truth, as dull."

This opinion she has, in effect, repeated in her published writings, but I had only heard her verbal expression of it, and I admired her courage. If she had been a man, struggling, as she then was, for a position in literature, she would not have dared to say half as much. For, what is very curious, the advocates of the classic authors—those I mean whom antiquity has more or less hallowed—instead of pitying those unhappy wights who confess their want of appreciation of them, fly at them with bludgeons, and dance upon their prostrate bodies with clogs.

> "For who would rush on a benighted man,
> And give him two black eyes for being blind?"

inquires the poet. I answer, "Lots of people," and especially those who worship the pagan divinities of literature. The same thing happens—but *their* fury is more excusable, because they have less natural intelligence—with the lovers of music. Instead of being sorry for the poor folks who have "no ear," and whom "a little music in the evening" bores to extremity, they overwhelm them with reproaches for what is in fact a natural infirmity. "You Goth! you Vandal!" they exclaim, "how contemptible is the creature who has no music in his soul!" Which is really very rude. Even persons who are not musical have their feelings. "Hath not a Jew ears?"—that is to say, though they have "no ear," they understand what is abusive language and resent it.

I am not saying one word against established reputations in literature. The very fact of their being established (even the "Rambler," for example, has its merits) is in their favor; and, indeed, some of the works I shall refer to are masterpieces. My objection is to the sham admiration of them, which does their authors no good (for their

circulation is now of no consequence to them), and is injurious not only to modern writers (who are generally made the subject of base comparison), but especially to the utterers of this false coin themselves. One can not tell falsehoods, even about one's views in literature, without injury to one's morals, yet to "tell the truth and shame the devil" is easy, as it would seem, compared with telling the truth and defying the critics.

I have alluded to the intrepidity of Miss Brontë in this matter, and, curiously enough, it is women who have the most courage in the expression of their literary opinions. It may be said, of course, that this is due to the audacity of ignorance, and a well-known line may be quoted (for some people, as I have said, are rude) in which certain angels (who are *not* women) are represented as being afraid to tread in certain places. But I am speaking of women who are great readers. Miss Martineau once confessed to me that she could see no beauties in "Tom Jones." "Of course," she said, "the coarseness disgusts me, but, apart from that, I see no sort of merit in it." "What!" I replied, "no humor, no knowledge of human life?" "No; to me it is a wearisome book."

I disagreed with her very much upon that point, and do so still; yet, apart from the coarseness (which does not disgust everybody, let me tell you), there is a good deal of tedious reading in "Tom Jones." At all events, that expression of opinion from such lips strikes me as noteworthy.

It may here be said that there are many English authors of old date, some of whose beauties are unintelligible except to those who are acquainted with the classics; and "Tom Jones" is one of them. Many of the introductions to the chapters, not to mention a certain travesty of an Homeric battle, must needs be as wearisome to those who are not scholars as the spectacle of a burlesque is to those who have not seen the original play. This is still more the case with our old poets, especially Milton. I very much doubt, in spite of the universal chorus to the contrary, whether "Lycidas" is much admired by readers who are only acquainted with English literature; I am quite sure it never touched their hearts as, for example, "In Memoriam" does.

I once beheld a young lady of great literary taste, and of exquisite sensibility, torn to pieces (figuratively) and trampled upon by a great scholar for venturing to make a comparison between those two poems. Its invocation to the Muses and the general classical air which pervades it had destroyed for her the pathos of "Lycidas," whereas to her antagonist those very imperfections appeared to enhance its beauty. I did not interfere, because the wretch was her husband, and it would have been worse for her if I had, but my sympathies were entirely with her. Her sad fate—for the massacre took place in public—would, I was well aware, have the effect of making people lie

worse than ever about Milton. On that same evening, while some folks were talking about Mr. Morris's "Earthly Paradise," I heard a scornful voice exclaim, "Oh! give *me* 'Paradise Lost,'" and with that gentleman I *did* have it out. I promptly subjected him to cross-examination, and drove him to that extremity that he was compelled to admit he had never read a word of Milton for forty years, and even then only in extracts from "Enfield's Speaker."

With Shakespeare—though there is a good deal of lying about *him*—the case is different, and especially with elderly people; for "in their day," as they pathetically term it, Shakespeare was played everywhere, and every one went to the play. They do not read him, but they recollect him; they are well acquainted with his beauties—that is, with the better known of them—and can quote him with manifest appreciation. They are, intellectually, in a position much superior to that of a fashionable lady of my acquaintance who informed me that her daughters were going to the theatre that night to see Shakespeare's "Turning of the Screw."

The writer who has done most, without I suppose intending it, to promote hypocrisy in literature is Macaulay. His "every schoolboy knows" has frightened thousands into pretending to know authors with whom they have not even a bowing acquaintance. It is amazing that a man who had read so much should have written so contemptuously of those who have read but little; one would have thought that the consciousness of superiority would have forbidden such insolence, or that his reading would have been extensive enough to teach him at least how little he had read of what there was to read; since he read some things—works of imagination and humor, for example—to such very little purpose, he might really have bragged a little less. One feels quite grateful to Macaulay, however, for avowing his belief that he was the only man who had read through the "Faerie Queen"; since that exonerates everybody—I do not say from reading it, because the supposition is preposterous—but from the necessity of pretending to have read it. The pleasure derived from that poem to most minds is, I am convinced, analogous to that already spoken of as being imparted by a foreign author: namely, the satisfaction at finding it—in places—intelligible. For the few who possess the poetic faculty it has great beauties, but I observe, from the extracts that appear in poetic selections and the like, that the most tedious and even the most monstrous passages are often the most admired. The case of Spenser in this respect—which does not stand alone in ancient English literature—has a curious parallel in art, where people are positively found to go into ecstasies over a distorted limb or a ludicrous inversion of perspective, simply because it is the work of an old master, who knew no better, or followed the fashion of his time.

Leigh Hunt read the "Faerie Queen," by the by, as almost everything else that has been written in the English tongue, and even Ma-

caulay alludes with rare commendation to his "catholic taste." Of all authors indeed, and probably of all readers, Leigh Hunt had the keenest eye for merit and the warmest appreciation of it wherever found. He was actively engaged in politics, yet was never blind to the genius of an adversary; blameless himself in morals, he could admire the wit of Wycherley; and, a freethinker in religion, he could see both wisdom and beauty in the divines. Moreover, it is immensely to his credit, that this universal knowledge, instead of puffing him up, only moved him to impart it, and that next to the pleasure he took in books was that he derived from teaching others to take pleasure in them. Witness his "Wit and Humor" and his "Imagination and Fancy," to my mind the greatest treasures in the way of handbooks that have ever been offered to students of English literature, and the completest antidotes to pretense in it. How many a time, as a boy, have I pondered over this or that passage in the originals, from Shakespeare to Suckling, and then compared it with the italicized lines in his two volumes, to see whether I had hit upon the beauties; and how often, alas! I hit upon the blots!*

It is curious that Leigh Hunt, whose style has been so severely handled (and, it must be owned, not without some justice) for its affectations, should have been so genuine (although always generous) in his criticisms. It was nothing to him whether an author was old or new; nor did he shrink from any literary comparison between two writers when he thought it appropriate (and he was generally right), notwithstanding all the age and authority that might be at the back of one of them. Thackeray, by the way, a very different writer and thinker, had this same outspoken honesty in the expression of his literary taste. In speaking of the hero of Cooper's five good novels—Leather-Stocking, Hawkeye, etc.—he remarks with quite a noble simplicity, "I think he is better than any of Scott's lot."

It is a "far cry" from the "Faerie Queen" to "Childe Harold," which, reckoning by years, is still a modern poem; yet I wonder how many persons under thirty—even of those who term it "magnificent"—have ever read "Childe Harold"? At one time it was only people under thirty who *had* read it; for poetry to the ordinary reader is the poetry that was popular in his youth—"no other is genuine."

> "A dreary, weary poem called the 'Excursion,'
> Written in a manner which is my aversion,"

* I remember (when "I was but a little tiny boy") I thought that "the fringed curtains of thine eye advance," addressed by Prospero to Miranda, must needs be a very fine line; imagine, then, my confusion, on referring for corroboration to my "guide, philosopher, and friend," as he truly was, to find this passage: "Why Shakespeare should have condescended to the elaborate nothingness, not to say nonsense, of this metaphor (for what is meant by 'advancing curtains'?) I can not conceive. That is to say, if he did condescend; for it looks very like the interpolation of some pompous declamatory player. Pope has put it into his 'Treatise on the Bathos.'"

is a couplet the frankness of which has always recommended itself to me (though I like the "Excursion"); but, except for the rhyme, it has a fatal facility of application to other long poems. Heaven forbid that I should "with shadowed hint confuse" the faith in a British classic; but, ye gods, how men have gaped (in private) over "Childe Harold"!

"Gil Blas," though not a native classic, is included in the articles of the British literary faith, not as a matter of pious opinion, but *de fide*—a necessity of intellectual salvation. I remember an interview I once had with a boy of letters concerning this immortal work. He is a well-known writer now, but at the time I speak of he was only budding and sprouting in the magazines—a lad of promise, no doubt, but given, if not to kick against authority, to question it, and, what was worse, to question *me* about it, in an embarrassing manner. The natural affability of my disposition had caused him, I suppose, to treat me as his father confessor in literature; and one of the sins of omission he confided to me was in connection with the divine Le Sage.

"I say—about 'Gil Blas,' you know—Bias [a great critic of that day] was saying last night that, if he were to be imprisoned for life with only two books to read, he would choose the Bible and 'Gil Blas.'"

"It is very gratifying to me," said I, wishing to evade my young friend, and also because I had no love for Bias, "that he should have selected the Bible, and all the more so since I should never have expected it of him."

"Yes, papa" (that is what the young dog was wont to call me, though he was no son of mine—far from it); "but about 'Gil Blas'? Is it *really* the next best book? And after he had read it—say, ten times—would he not have been rather sorry that he had not chosen—well, Shakespeare, for instance?"

The picture of Bias with a long white beard, the growth of twenty years, reading that tattered copy of "Gil Blas" in his cell, almost affected me to tears, but I made shift to answer gravely: "Bias is a professional critic, and persons of that class are apt to be a little dogmatic and given to exaggeration. But 'Gil Blas' is a great work. As a picture of the seamy side of human life, of its vices and its weaknesses at least, it is unrivaled. The archbishop—"

"Oh, I know that archbishop—*well*," interrupted my young tormentor. "I sometimes think, if it hadn't been for that archbishop, we should never perhaps have heard of 'Gil Blas.'"

"Tchut, tchut!" said I; "you talk like a child."

"But to read it *all through*, papa—three times, ten times, for all one's life? Poor Mr. Bias!"

"It is a matter of opinion, my dear boy," I said. "Bias has this great advantage over you in literary matters, that he knows what he is talking about, and if he was quite sure—"

"Oh! but he was not quite sure; he was rather doubtful, he said, about one of the books."

"Not the Bible, I do hope?" said I fervently.

"No, about the other. He was not quite sure but that, instead of 'Gil Blas,' he ought to have selected 'Don Quixote.' Now, really that seems to me worse than 'Gil Blas.'"

"You mean less excellent," I rejoined; "you are too young to appreciate the full signification of 'Don Quixote.'"

The scoundrel murmured, "Do you mean to tell me that people read it when they are old?" but I pretended not to hear him. "We do not all of us," I went on, "know what is good for us. Sancho Panza's physician—"

"Oh! I know that physician—*well*, papa. I sometimes think, if it had not been for that physician, perhaps—"

"Hush!" I exclaimed authoritatively; "let us have no flippancy, I beg." And so, with a dead lift, as it were, I got rid of him. He left the room muttering, "But to read it through—three times, ten times, for all one's life?" And I was obliged to confess to myself that such a prolonged course of study, even of "Don Quixote," would have been wearisome.

Rabelais is another article of our literary faith that is certainly subscribed to much more often than believed in. In a certain poem of Mr. Browning's (*I* call it the "Burial of the Book," since the Latin name he has given it is unpronounceable, even if it were possible to recollect it), charmingly humorous, and which is also remarkable for impersonating an inanimate object in verse as Dickens does in prose, there occur these lines:

> "Then I went indoors, brought out a loaf,
> Half a cheese and a bottle of Chablis,
> Lay on the grass, and forgot the oaf
> Over a jolly chapter of Rabelais."

Yet I have known some wonder to be expressed (confidentially) as to where he found the "jolly chapter," and the looking for the beauties of Rabelais to be likened to searching in a huge bed of manure for a few heads of asparagus.

I have no quarrel with Bias and Company (though they stick at nothing, and will presently say that I don't care for these books myself), but I venture to think that they are wrong in making dogmas of what are, after all, but matters of literary taste; it is their vehemence and exaggeration which drive the weak to take refuge in falsehood.

A good woman in the country once complained of her step-son, "He will not love his learning, though I beats him with a jack-chain"; and from the application of similar aids to instruction the same result takes place in London. Only here we dissemble and pre-

tend to love it. It is partly in consequence of this that works, not only of acknowledged but genuine excellence, such as those I have been careful to select, are, though so universally praised, so little read. The poor student attempts them, but, failing—from many causes, no doubt, but also sometimes from the fact of their not being there—to find those unrivaled beauties which he has been led to expect in every sentence, he stops short, where he would otherwise have gone on. He says to himself, "I have been deceived," or "I must be a born fool"; whereas he is wrong in both suppositions. I am convinced that the want of popularity of Walter Scott among the rising generation is partly due to this extravagant laudation; and I am much mistaken if another great author, more recently deceased, will not in a few years be added to the ranks of those who are more praised than read from the same cause.

The habit of mere adhesion to received opinion in any matter is most mischievous, for it strikes at the root of independence of thought; and in literature it tends to make the public taste mechanical. It is very seldom that what is called the verdict of posterity (absurdly enough, for are not *we* posterity?) is ever reversed; but it has chanced to happen in a certain case quite lately. The production of "The Iron Chest" upon the stage has once more brought into fashion "Caleb Williams." Now, that is a work, though by no means belonging to the same rank as those to which I have referred, which has a fine old crusted reputation. Time has hallowed it. The great world of readers (who have never read it) used to echo the remark of Bias and Company, that this and that modern work of fiction reminded them—though at an immense distance, of course—of Godwin's masterpiece. I remember Le Fanu's "Uncle Silas," for example (from some similarity, more fanciful perhaps than real, in the isolation of its hero), being thus compared with it. Now, "Caleb Williams" is founded on a very fine conception—one that could only have occurred, perhaps, to a man of genius; the first part of it is well worked out, but toward the middle it grows feeble, and it ends in tediousness and drivel; whereas "Uncle Silas" is good and strong from first to last. Le Fanu has never been so popular as, in my humble judgment, he deserves to be, but of course modern readers were better acquainted with him than with Godwin. Yet nine out of ten were always heard repeating this cuckoo cry about the latter's superiority, until "The Iron Chest" came out, and fashion induced them to read him for themselves; which has very properly changed their opinion.

I remember, in my own case, that, from that mere reverence for authority which I hope I share with my neighbors, I used to speak of "Headlong Hall" and "Crotchet Castle"—both great favorites of our forefathers—with much respect, until one wet day in the country I found myself shut up with them. I won't say what I suffered;

better judges of literature than myself admire them still, I know. I will only remark that *I* don't admire them. I don't say they are the dullest novels ever printed, because that would be invidious, and might do wrong to works of even greater pretensions; but to my mind they are dull.

When Dr. Johnson is free to confess that he does not admire Gray's "Elegy," and Macaulay to avow that he sees little to praise in Dickens and Wordsworth, why should not humbler folks have the courage of their own opinions? They can not possibly be more wrong than Johnson and Macaulay were, and it is surely better to be honest, though it may expose one to some ridicule, than to lie. The more we agree with the verdict of the generations before us on these matters, the more, it is quite true, we are likely to be right; but the agreement should be an honest one. At present very extensive domains in literature are, as it were, inclosed and denied to the public in respect to any free expression of their opinion. "They are splendid, they are faultless," cries the general voice, but the general eye has not beheld them. Nothing, of course, could be more futile than that, with every new generation, our old authors who have won their fame should be arraigned anew at the bar of public criticism; but, on the other hand, there is no reason why the mouths of us poor moderns should be muzzled, and still less that we "should praise with alien lips."

"Until Caldecott's charming illustrations of it made me laugh so much," said a young lady to me the other day, "I confess—though I know it's very stupid of me—I never saw much fun in 'John Gilpin.' She evidently expected a reproof, and when I whispered in her ear "Nor I," her lovely features assumed a look of positive enfranchisement.

"But am I right?" she inquired.

"You are certainly right, my dear young lady," said I, "not to pretend admiration where you don't feel it; as to liking 'John Gilpin,' that is a matter of taste. It has, of course, simplicity to recommend it; but in my own case, though I'm fond of fun, it has never evoked a smile. It has always seemed to me like one of Mr. Joe Miller's stories put into tedious verse."

I really almost thought (and hoped) that that young lady would have kissed me.

"Papa always says it is a free country," she exclaimed, "but I never felt it to be the case before this moment."

For years this beautiful and accomplished creature had locked this awful secret in her innocent breast—that she didn't see much fun in "John Gilpin." "You have given me courage," she said, "to confess something else. Mr. Caldecott has just been illustrating in the same charming manner Goldsmith's 'Elegy on a Mad Dog,' and—I'm very sorry—but I never laughed at *that* before, either. I have pretended

to laugh, you know," she added, hastily and apologetically, "hundreds of times."

"I don't doubt it," I replied; "this is not such a free country as your father supposes."

"But am I right?"

"I say nothing about 'right,'" I answered, "except that everybody has a right to his own opinion. For my part, however, I think the 'Mad Dog' better than 'John Gilpin' only because it is shorter."

Whether I was wrong or right in the matter is of no consequence even to myself; the affection and gratitude of that young creature would more than repay me for a much greater mistake, if mistake it is. She protests that I have emancipated her from slavery. She has since talked to me about all sorts of authors, from Sir Philip Sidney to Washington Irving, in a way that would make some people's blood run cold; but it has no such effect upon me—quite the reverse. Of Irving she naïvely remarks that his strokes of humor seem to her to owe much of their success to the rarity of their occurrence: the flashes of fun are spread over pages of dullness, which enhance them, just as a dark night is propitious to fireworks, or the atmosphere of the House of Commons, or a court of law, to a joke. She is often in error, no doubt, but how bright and wholesome such talk is as compared with the platitudes and commonplaces which one hears on all sides in connection with literature!

As a rule, I suppose, even people in society ("the drawing-rooms and the clubs") are not absolutely base, and yet one would really think so, to judge by the fear that is entertained by them of being natural. "I vow to Heaven," says the prince of letter-writers, "that I think the Parrots of Society are more intolerable and mischievous than its Birds of Prey. If ever I destroy myself, it will be in the bitterness of having those infernal and damnable 'good old times' extolled." One is almost tempted to say the same—when one hears their praises come from certain mouths—of the good old books. It is not every one, of course, who has an opinion of his own upon any subject, far less on that of literature, but every one can abstain from expressing an opinion that is not his own. If one has no voice, what possible compensation can there be in becoming an echo? No one, I conclude, would wish to see literature discoursed about in the same pinchbeck and affected style as are painting and music;* yet that is what will happen if this prolific weed of sham admiration is permitted to attain its full growth.—*Nineteenth Century.*

* The slang of art-talk has reached the "young men" in the furniture-warehouses. A friend of mine was recommended a sideboard the other day as not being a Chippendale, but "having a Chippendale *feeling* in it."

THE IMPEDIMENT OF ADIPOSE.—A CELEBRATED CASE.

By E. VALE BLAKE.

FROM the days of Hippocrates, intelligent medical observers have noticed that an unusual accumulation of fat, far from adding to the strength of a person, was a source of physical weakness, and, to a certain extent, an outward sign of incapacity; that it limited activity and shortened life. It is only in comparatively modern times that scientific experimentalists have ascertained precisely how the system generally, and the heart particularly, is affected either by the overloading or infiltration of superfluous fatty matter upon or in its muscular substance. In fact, it was not until the microscope was carefully applied to the investigation that the disease now known as "fatty degeneration" was really understood.

Every one knows that a certain amount of adipose matter in the human system impedes rapidity of motion. No sportsman would back a pedestrian who turned the scale at three hundred pounds, for instance; but there are other kinds of impedimenta to the human faculties which are certainly to be traced to superfluous fat, though this is rarely suspected of being the cause. A common case is that of the obese gourmand who complains that nothing tastes as it used to; on whose palate, formerly so sensitive, everything palls, and fails to awaken the delicious sensations of former days. He is very apt to attribute the change to the incompetent *chef de cuisine*, or even to degenerate Nature herself, in not growing the same quality in bird or fish; while the looker-on is apt to imagine that the change results from mere satiety. But suppose we had our fat friend on the dissecting-table, what should we probably find? No doubt, insidious deposits of fatty matter which have impeded the lively sensations of the organs of taste and smell, the latter of which so greatly aids the imagination and assists in the pleasure of the table. In the "Medico-Chirurgical Transactions," of 1870, Dr. W. Ogle gives five distinct cases of *anosmia* arising from an excess of fatty deposit permeating the cells of the olfactory apparatus.

Still more curious, and as generally unsuspected, is the deposit of adipose tissue as a cause of deafness; and this not directly in the organs of hearing, but in the canals leading to the air-passages of the nose and throat. This naturally requires some explanation to non-professionals, though the fact is well established. It results from the sympathetic connection which is formed by the continuous mucous membrane, which covers at once the interior of the mouth and throat, the pendulous palate, the tonsils, the isthmus of the fauces, and the

pharynx, etc.; this same web of membrane is carried to the Eustachian tubes (which lead from the back part of the mouth to the cavity of the ear), and thus it is that what only visibly affects one portion, say the lachrymal canal, or the tonsils, may sympathetically disorder the sense of taste or hearing. The substance of this mucous membrane is composed of three layers, containing a cellular or folliculous system of roundish or oval cells, which are subject to morbid alterations, that affect parts far removed from the local appearance of disorder. Thus, Dr. Harvey reports: "I have seen and treated many cases of deafness which appeared to depend solely on nasal obstruction from adipose deposit. It does this by interfering with or impeding the entrance of the air to the mouth of the Eustachian tubes, undue limitation of air lessening the sensibility and acuteness of the auditory organ. These cases usually occur in persons of great corpulence, in which case local treatment is almost valueless. The corpulence itself must be reduced."

We might go on and point out many physical ills which result from obesity, and we will name a few; but our principal object in these pages is to show that a *redundance of adipose matter essentially weakens and impedes the power of the will.* We know that it disinclines to activity, produces shortness of breath, palpitation of the heart, and comparative weakness in proportion to size, and is often accompanied by anæmia. We can make this clearer, perhaps, by an illustration. The normal weight of a man five feet in height is 120 pounds; of a man five feet ten inches, 169 pounds. Now, suppose the latter really weighs 300 pounds by accumulation of fat, what results but that all this superfluous matter has to be supplied with capillaries, and these have to get blood from vessels only constructed to circulate the original quantity? No wonder is it that the circulation is enfeebled and impeded! By this increase of adipose there is no increase of propelling force. Hence, the overstrain upon the capillaries and the ensuing comparative weakness in the vital functions are explained, and also why external injuries are less easily repaired.

It is a well-settled rule in all animal structures that, when the quantity of fat exceeds the law of their construction, bulk becomes a source of imperfect equilibrium, and therefore of danger. The most bulky animals are not the most useful nor the strongest. An elephant compared with its size is not as strong as an ant. Then there is this physiological fact, that the oleaginous principle is actually less alive than any other part of an animal. Observe the blubber of a whale, into which parasites bore an inch deep without causing any inconvenience, and into which a harpoon may be thrust without serious injury if it does not penetrate to the muscular substance. The quantity of fatty matter in animals seems to bear an inverse relation to the quantity of bodily and mental activity. Hibernating animals, who may be said to live on their own fat, are

the perfection of indolence. All shepherds know that a very fat ewe will not produce a strong lamb.

Some Brahmans pride themselves on their obesity—did one of them ever run a race, or write a book? Chesterfield said that fat and stupidity were such inseparable companions that they might be used as convertible terms. We should not be willing to indorse that opinion exactly; but, if he had said fat and inactivity, he would not be far wrong—though we have seen exceptions even to this. But it is undoubtedly true as a rule. Carnivorous animals that have to earn their dinners are generally thin; domestic ruminants are fat. Animals shut up in cages either pine and die or get fat. At Strasburg, famous for *pâté-de-fois-gras*, geese are shut up in warm coops and overfed to produce the fat (and diseased) livers so much admired by gourmets. In Italy, wealthy connoisseurs are very fond of fat ortolans, and this is the device by which they obtain them: They shut the birds up in a dark chamber, (knowing that in their natural state it is their habit to feed at sunrise). They then arrange artificial lights which can be cast at will into the dark prison of the birds, on seeing which the ortolans immediately seek the food which is provided for them; the light is withdrawn, and they go to sleep; after a few hours it is again introduced, and so the process is repeated five or six times in the twenty-four hours, so that the birds are kept constantly feeding or sleeping; the consequence is, that in about three days the ortolan becomes "a delicious ball of fat," and ready for the table.

In the human being there is, however, a difference, just as there is in the domesticated animals; there is what is known as "good fat," which must not of course be too redundant, and "bad fat." The fat of the florid person may generally be classed with the good, that of the flabby anæmiac with the bad: the latter is recognized in the unwholesome look of the chronic victim of alcohol.

But, to turn from the purely physical aspects of adipose, we wish to invite the reader's attention to a celebrated case of the impediment of adipose in affecting the mental character, and the action or inaction superinduced by this malady.

One of Shakespeare's famous characters—we should say perhaps his supreme portrait—is described thus with one dash of the pen:

"*He's fat and scant of breath!*"

The character of Hamlet has suffered such constant distortion at the hands of commentators, and has been made unintelligible and mysterious through a very natural but fatal oversight, namely, the habitual neglect of the annotators to take into the account the physical organization of the Danish Prince—an oversight which the poet never made. He never failed to make the *physique* conform to the character.

Every shade of capacity and ingenuity has been expended on the consideration and explanation of Hamlet's mental traits, but unfortunately with an essential factor left out. Not one, of all the numerous writers who have essayed to enlighten the world on the meaning and intent of this "consummate flower" of the poetic insight, has thought to inquire whether the body was not that "unknown quantity" which confounded Schlegel, and which Goethe thought he had found in the lines—

> "The time is out of joint; O cursed spite!
> That ever I was born to set it right!"—

that is, that the Prince was overborne by the too great pressure of an Herculean task with which he was conscious he had not the ability to cope. But that there was really no insufficiency of mental power appears patent at every forward movement of the play. He perceives the situation clearly, argues about it rationally, notes all the circumstances, and acknowledges his own duty in the premises; but he does not *do* the thing which he sets before himself to perform.

Why? Because "he's fat and scant of breath"—in other words, is weighted down with a non-executive or lymphatic temperament.

Painters, as well as actors, have done much to foist a false Hamlet upon the public imagination. He has habitually been represented by both as possessing a nervous, bilious, saturnine temperament, for which there is no warrant in the poet's description of him. Artists have portrayed him as fleshless and dark-hued. Fechter, the sole exception, did indeed remember his nationality to the extent of introducing the novelty of a flaxen wig, which was barely tolerated by the audience, so counter to the truth was the ill-taught popular fancy. But who has yet dared, on canvas or on the stage, to present a true Shakespearean Hamlet "grunting and sweating under his weary load of life"?—so fat really as to need that "napkin" which the queen offers him to wipe the perspiration from his brow.*

Yet is this "fat" the keynote and solution of the "mystery of Hamlet."

Remembering that he was fat and scant of breath, we can readily understand many things which are otherwise certainly perplexing; particularly the inconsistency between his thoughts and desires and his chronic inaction. He would represent in modern life those persons whose cerebral developments are put down at maximum figures by the expert phrenologist, and who exhibit to admiring friends their large brain-power as thus indicated, but who never do anything to confirm the diagnosis. Again, why? because they lack the energizing temperament without which the brain is but a dumb mass of latent possibilities.

* Profuse perspiration is a recognized symptom of one form of heart-disease—endocarditis.

The character of Hamlet is generally conceded to be the most wonderful production amid all that vast galaxy of dramatic figures which has enchanted the world for three hundred years, and if one new to the subject inquires why it thus takes precedence of Lear, Othello, Macbeth, Shylock, and their proximate peers, we must first answer negatively that it is not because there is so much deeper philosophy in Hamlet than may be found, scattered pearl-like, throughout all the plays by the same master hand, nor because any single passion is therein better delineated—but, affirmatively, because in the Prince of Denmark there is combined the greatest complexity of mental acumen, allied to an unparalleled variety of passional influxes, and bound, alas! to an inefficient temperament. It is not one master passion which stirs, nor one affection alone that is outraged; not one sole grief that afflicts, or one emotion which reigns supreme over that great but erratic mind: it is a commingling of jarring elements, most difficult to reconcile in the formation of a characteristic individuality.

In the rising tide of the Moor's jealousy we have the most vivid description of a half-savage tornado of mental suffering, produced by the uncontrolled agonies of a strong but simple and ill-balanced mind; in Lear, an already tottering intellect, quite overthrown by the cruel irritations of unimagined ingratitude; in Macbeth, an unsafe ambition troubled with a conscience; in Shylock, a member of an outraged race, essaying an hereditary revenge, stimulated by avarice: but in Hamlet we have a whole circle of passions, a complication of emotions to draw into one converging action, like an engine required to run on a main road with many branches, and no steam in the boiler.

To particularize: there is first his natural sorrow for the death of his father; sorrow, anger, and chagrin at the hasty marriage of his mother; hatred and suspicion of his uncle; his loss of the crown of Denmark for an indefinite time; the necessity for concealing his suspicions as to the "taking off" of the King; the perplexing and terrifying impressions produced by the vision of the ghost; its adjuration to active revenge; his love for Ophelia, and its interruption apparently at her own caprice; the annoying surveillance of old Polonius; distrust of his old school friends, Guildenstern and Rosencrantz; the voluntary assumption of the rôle of madness, and the necessity of combining this with the retention of his true mental status with certain of his friends; his unintended injury of Ophelia and her brother through his "brainish" homicide of their father, when he had hoped to slay the King; the distressing madness and death of Ophelia, with her scanty burial rites—imperiling her soul, in the common opinion of the time; the encounter with the irate Laertes: all these and minor complications and difficulties were thrust upon him, a situation scarcely to be successfully encountered by a soul incased in the very fittest framework which nature ever contrived as its instrument for setting a dis-

jointed world to rights—by one whose blood and judgment were so well commingled that every thought is not only wise and just but also briefly precedent to action.

Now, what has our Shakespeare done in this masterpiece of dramatic composition, but *allied all these untoward events and tempestuous emotions of a great, grieved soul to a body physically unadapted to success?*

This is the "mystery of Hamlet," and the world has been long making the discovery.

Hamlet's "too too solid flesh" caused him to procrastinate. Had it not been for that weight of adipose substance he "were simply the most active fellow in Europe"; but the inertia of fat was like gyves upon his hands and feet, and could not be overcome except under extraordinary provocation, and then, the sudden impulse subsided, flagged again, mastered by the chronic habit of (let us give the right word, though the heavens fall!)—laziness!—the result of his "fatty degeneration."

We know that we have to encounter the settled prejudices of the world against us in this view of the character of Hamlet. We certainly had our own preconceived notions to conquer before arriving at this conviction; but a close examination of the text undoubtedly bears it out, and indeed we can see no other satisfactory solution of the problem offered, by the contradictions of the clear reasonings and the muddled deeds of the Prince of Denmark.

That the above scientific but simple explanation has not been previously reached by some one of the many keen and learned critics of the play, is only to be accounted for by the transcendent attraction of the intellectual traits displayed therein. The pivotal point in nearly all these discussions being the question whether the dramatist really intended to portray an assumed or real insanity—and certainly, ignoring the theory we now propound, that must ever remain a mooted point; but, admitting the dominant power of his "too solid flesh," every apparent inconsistency is accounted for.

In the very first scene of the first act we get an intimation, though no description, of Hamlet's physical temperament. Why, we may well ask, should the poet represent the Ghost as first appearing to certain officers of the guard, to whom it had no communication to make, and to whom none was necessary, unless it was to show a certain lack of sensitiveness to spiritual influences in the Prince, an absence of that refinement of nerve which originates, by attraction, spiritual influences? This preliminary stalking suggests a certain grossness of material texture in the Prince not present, for instance, in Horatio. The son of the royal Dane needed, it seems, a better attuned medium to put him *en rapport* with his own father's spirit. Here we have the first intimation, a sort of prelude as it were, amply borne out by the succeeding events, that in everything which was to be really accom-

plished others must take the initiative. The very expression which Hamlet uses in that frenzied burst of passion on parting with the Ghost, "While memory holds a seat in this distracted *globe*," is suggestive of a rotund and corpulent person. We can not conceive of the phrase-culling poet applying it to the narrow *caput*, for instance, of Master Slender, but must believe that Shakespeare kept well in mind the *personnel* of his hero; in fact, when did he ever forget that important item in the description of his creations! Indeed we are very soon again reminded of the characteristic physical development of the Prince by the expression Ophelia makes use of when she applies the term "bulk" in her sad description of Hamlet's visit to her closet.

"He raised a sigh * so piteous and profound
As it did seem to shatter all his *bulk*."

Bulk! the very word Shakespeare employs to describe the ponderous Wolsey—"His very *bulk* take up the rays o' the beneficial sun."

Ophelia had taken an accurate survey—she notes the disorder of his garments, mentions that he is pale (a symptom of anæmic adipose), but gives no hint that he has "fallen away vilely," which would have been the first thing to attract the attention of a young lady who believed one mad for the love of her. No, his "bulk" is evidently undiminished either by love or lunacy.

As with Ophelia, so with all the persons who address or describe him, none make any comment which would suggest a thin or haggard appearance. When Polonius describes to the King the course of the seeming madness, he confines himself exclusively to the mental analysis, and makes no mention that the Prince's body has succumbed to the malady. When the King drinks to him, it is not to his better health or better wits, but to his "better breath"! And the Queen-mother, watching him anxiously during the passage-at-arms with Laertes, makes the exclamation which we have taken as the keynote of our theory, "He's fat and scant of breath." And then, with instinctive maternal tenderness calls to him, "Here, Hamlet, take my napkin, rub thy brow"; which he not heeding, she repeats, "Come, let me wipe thy face."

Can we not see the perspiration trickling over the broad, heavy cheeks as we read these lines? It was surely from experience that he spoke of "sweating and grunting under a weary life."

That he is consciously represented as feeling the impediment of the weight of his own flesh is clearly discerned by the frequent references to it. A gaunt, thin, wiry, or even an ordinary muscular man, would not be apt to describe his flesh as "too solid," or to enumerate as one of the serious ills of humanity "the *grunting* and sweating under

* Medical men indicate frequent sighing as a sign of heart-disease, caused by superfluous fat.

burdens." In Hamlet's description of himself to Guildenstern, where he says he "has lost all his mirth," and so forth, it is still the dejection of his mind which he puts forward: he does not pretend to excite sympathy by pointing to his failing body. So in his complimentary address to Horatio, who appears to him to be so fortunately endowed, physically and mentally, he recognizes in his friend that favorable constitution where the blood and will power are so equably adjusted that they "are not a pipe for Fortune's finger to sound what stop she please." In other words, Horatio was seen to possess what the speaker was conscious of lacking, a constitution in which the body is subordinate to the will, a temperament which Hamlet had not, but quite the reverse—in which the will was dominated by the body. This he vaguely feels but can not explain, and so he soliloquizes:

> "I do not know why yet I live to say
> This thing's to do"—

except that he was a "muddy-metalled rascal"; but we perceive clearly enough that it was not his brain but his body which was muddy-metalled.

Again, he evidently feels the drag-anchor of his heavy mold, and the consequent ill-coöperation of his bodily frame with his discerning spirit, when even under great excitement he stops to explain that he "is not splenetic and rash," though yet there is a sort of ground-swell of "something dangerous" in him. Yes, dangerous if sufficiently aroused; but his was a kind of nature which could endure a great deal of arousing before it culminated in action. When he takes his leisurely walk in the hall this quiet exercise goes under no other name with him than a "breathing-time"; and, once familiarized with his true physical picture, how apt appears his reply to Osric: "Sir, I will walk here in the hall; if it please his Majesty, this is the *breathing-time* of day with me."

When he apologizes to Laertes, he says, "You must needs have heard how I am punished with a sore distraction." He says "heard," because he is conscious that there is nothing in his appearance to indicate failing health, and this under the circumstances he would scarcely have omitted had he lost any of his superfluous flesh. He was himself a keen observer of physiological peculiarities, was ready enough to detect changes in the personal appearance of others, and therefore would have been thoroughly conscious of his own had any marked falling away taken place. Notice his reception of the players. One he addresses thus:

> "O old friend, why thy face
> Is valanced [wrinkled] since I saw thee last."

And to her who is to play the Queen—

"By'r lady,
Your ladyship's nearer to heaven
Than when I saw you last, by
The altitude of a chopine."*

An executive temperament would have needed no other incitement, one would think, to action than the reproving adjuration of the ghostly visitant.

"Duller than the fat weed
That rots itself at ease on Lethe's wharf"

must that son have been who could passively subside after such a nocturnal interview; yet Hamlet stops, considers, hesitates, questions, and —does nothing. Not from any thought that it was a crime to revenge even a father's murder by killing another; no, for he deliberately postpones the most favorable opportunity of revenge which occurs, that he may at some future time insure the killing of his uncle's soul, as well as his body, by taking him, if possible, while he was about some act "that had no relish of salvation in't."

To conceal from himself the evident pusillanimity of his course he assumes the rôle of lunacy, which required no violent exertion and afforded ample time for meditation, delay, and the use of other persons to accomplish his ends. It seems also a cover for cowardice, in that he expects the mantle of his assumed malady to cover him from blame in the execution of that long-considered vengeance he is never destined to take; for, when at last he does stab the King, there is no thought of his father in his mind; it is but the reprisal for later treacheries aimed at his own life. This rôle of madness, however, only causes a stricter watch to be put upon him; nor does it help him forward one step toward the fulfillment of the Ghost's injunction. The accidental arrival of the players is indeed seized upon and applied by him to the purpose of testing the truth of the ghostly asseverations; but he had evidently never thought of sending for them, for the purpose of questioning the King's conscience—the opportunity was thrust upon him.

The moment of confusion which ensues at the *dénouement* of that plot, when the King arises in remorseful perturbation, would have seemed to furnish the precise instant when vengeance would have been commended by justice; but the unequaled opportunity is allowed to pass with merely a satirical jest.

That Hamlet meant to slay the King, when he really killed Polonius, is but cumulative evidence that the excitement of the interview with his mother (sought by her, not him) was the immediate cause of his rash and ill-directed act. It was not premeditated, and required no courage, as the party behind the tapestry had no opportunity of defense, and the act can scarcely be considered as part of his settled pur-

* *Chopine*, a high-heeled shoe, or clog.

pose to revenge his father's death. Like all persons of a lymphatic temperament, Hamlet could be suddenly aroused to a high pitch of daring, but was utterly incapable of persistent effort. He follows the Ghost to the edge of the cliff in defiance of the warnings of his companions, threatening to "make a ghost of him that lets me"—he could make a sudden stab in the hangings of his mother's apartment—could leap into the grave with Laertes, and outrave the latter's frenzied demonstration, with the self-asserted passion of "forty thousand brothers," but it was soon over. The immediate cause of excitement being removed, he returns to his natural inactivity.

The episode of the voyage to England at the instance of the King, submitted to without protest, is a terrible descent from the sublime grandeur of his philosophizing and thunderous threats. A tame passivity rules him; but, discovering the imminence of his danger on the voyage, there is revealed a cunning cruelty in his nature that the brave, active man would have scorned. But persons who are noted for their general inertia, when they do move, are very liable to astonish by the intensity and unexpected turn of their action.

Once again, toward the close of the play, we get another insight into the torpid constitution of the Prince. In the preliminary discussion with Horatio as to his fitness for the duel with Laertes, his friend says:

"You will lose the wager, my lord."

And Hamlet replies: "No, I shall win at the odds; but thou wouldst not think *how ill all's here about my heart;* but it's no matter." Just such an answer as a person might make who was suffering from "fatty degeneration." Evidently, in the opinion of the writer, the consideration of the unpleasant possibilities of the duel had brought the action of the heart almost to a standstill—the result of a chronic, sluggish circulatory system. Had his blood been accelerated, as would naturally have occurred in a nervous temperament, other expressions would have been more fitting; but the phrase above quoted better indicates partial stagnation than anything else. His philosophy, indeed, "defies augury," but his physical organization can not choose but respond to the near presence of a fatal venture. With the one not surprising exception of the first sight of the Ghost, Hamlet is throughout like the obese class generally which he represents, sufficiently careful of his personal safety. He puts himself to no bodily risk. In leaping into the open grave after Laertes, it must be remembered that he is on his native heath, as it were, surrounded by friends, while the unfortunate brother is the alien and unwelcome guest; and the apparent calmness but real tremor with which he accepts the invitation to a passage at arms is painfully betrayed by the abnormal action of the heart above referred to: besides, in that age it required more courage to decline a duel than to accept one.

The medley of the last scene, including the death of the King,

though the latter is finally slain by Hamlet, is all brought about by the management of other heads and hands, and its conclusion evidently unforeseen by the Prince. From first to last he accomplishes nothing of set purpose. He moralizes by temperament and habit, but *acts only when inaction is the more difficult resource.* The fine spirit, the clear insight, the keen reader of other men's thoughts, is *imprisoned in walls of adipose,* and the desire for action dies out with the utterance of wise maxims, philosophic doubts, and morbid upbraidings of his own inertness. Hamlet is like one of those persons (to be met with in every community) who can relieve themselves by talking. This is a kind of character well understood by Shakespeare. In the third Richard's conference with the murderers of Clarence, one replies to him :

> "Tut, tut, my lord, we will not stand to prate;
> Talkers are no great doers."

Again, in describing a character the very opposite to that of Hamlet —one of few words, Cordelia—the poet makes her say, "What I well intend, I'll do't *before* I speak." Now, of all the characters drawn by Shakespeare, Hamlet is preëminently the man of words; not only his famous soliloquies but his dialogues take up unwonted space; he is the most prolific moralizer of the dramatist's conception, and thus all practical manhood is allowed to ooze out in words.

To judge the better whether Shakespeare intended in this play to show how the body may clog the aspirations of the mind, we have only to observe that whenever the physical appearance of any character is described by him, we find that leanness is an element of the executive man, and "bulk" or fatness of the dilatory and procrastinating, just as we see it in every-day life. Says Prince Henry to Falstaff :

> "What! stand'st thou idle here? Lend me thy sword!"

And the fat knight replies :

> "O Hal, I prithee give me leave to *breathe* awhile"—

the very expression used by both the King and Queen in regard to Hamlet, and in which he also describes his own case.

On another occasion Prince John addresses the pseudo-hero of Salisbury Plain :

> "Now, Falstaff, where have you been all this while?
> —When everything is ended, then you come."

And the inimitable old rogue, knowing that he must be pardoned for his fat, answers :

> "Do you think me a swallow, an arrow, a bullet?"

So also Cæsar, recognizing the physiological improbability of a fat man actually carrying out a treasonable conspiracy, says :

> "Let me have men about me that are fat."

And of Cassius—

> "Would he were fatter!
> If my name were liable to fear,
> I do not know the man I should avoid
> As soon as that spare Cassius."

Macbeth was not fat, nor Richard III., nor Henry V., nor Harry Hotspur. They did the things which they planned to do. They did not have to stop to "breathe" themselves like the Prince of Denmark. Who can possibly conceive of a fat Coriolanus? The fat man may be greedy and avaricious like Cardinal Wolsey, or witty and sensual like old Jack, or brooding and melancholy like Hamlet; but he who can vault into his saddle "like feathered Mercury" will ever win the day by action.

Hamlet's uncle-father might confidently have left the unhappy philosopher to his questionings and musings; had he not set his own trap he might have finished his reign in safety, if not in peace, for the Hamlet of Shakespeare, unlike the real Hamlet of Saxo Grammaticus, would no more have set the palace on fire than he would have produced a conflagration of the Skager Rack—for he was "fat and scant of breath," impeded at every step by a superfluity of adipose.

THE MARTYRDOM OF SCIENCE.

By J. W. SLATER.

THE history of human progress presents no feature more interesting yet more commonly overlooked and misrepresented than the treatment of discoverers and inventors. That these men have, as a rule, fared ill at the hands of their species is carelessly or grudgingly admitted. But the questions by whom have they been persecuted, and what may have been the motive of their enemies, are avoided even in works where we might expect them to be carefully discussed and fully answered. Such omission may be especially charged against Sir D. Brewster. His treatise is merely a biography of certain astronomers who have been, for anything the reader learns to the contrary, incidentally and casually afflicted by their contemporaries, and it omits the most striking instances of persecution. Nay, the very term "martyrs of science" is applied quite vaguely, and is made, e. g., in the work of M. Tissandier, to include three distinct classes of men. We have on the one hand personages whose love for research has cost them health and even life itself. We find physicists like Richmann, chemists like Gehlen, Mansfield, Chapman, who have been struck dead while engaged in some hazardous experiment. We read of naturalists like Marcgrave and the elder Wallace, geographers, navigators, and trav-

elers, such as Cook, La Perouse, Franklin, Livingstone, meteorologists like Crocé-Spinelli, who in their ardor for discovery have succumbed to ungenial climates, to the attacks of savages, to hunger, tempest, or to an irrespirable atmosphere. All honor to these men, and to the noble army of which they may be taken as representatives! They have fallen in the cause of science, but they have undergone no persecution, and may hence be regarded as victims rather than martyrs.

We turn to another class: illustrious inventors and discoverers not a few have been clearly and decidedly persecuted; hunted down by mob-violence, imprisoned, or even judicially murdered; but these inflictions are to be traced not to their scientific discoveries, speculations, and writings, but to their religious or political opinions. When the house of Priestley was sacked and burned by the rabble of Birmingham, and when his very life was endangered, it was not the chemist and physicist but the so-called "Jacobin" and Socinian whom Midland roughdom sought to crush. It is not, we believe, generally known that the attack on Priestley's house was headed by the town-crier, a man of the name of Sugar, who rang his bell and exclaimed:

"Pile up the wood higher,
I am Sugar, the crier;
By my desire
This place was set on fire!"

This man and his doggerel are only worth our notice as proof of the official countenance lent to the outrage. It is utterly incredible that a town-crier would thus avowedly act as the ringleader of a mob unless sure of the connivance of his superiors.

If Campanella was put seven times to the torture, on one occasion for forty hours in succession; if he passed twenty-seven of the best years of his life in loathsome dungeons; if, after his release, he narrowly escaped the rage of a brutal populace, it was not as the champion of the Copernican system of astronomy, the refuter of mediæval Aristotelianism, but as a patriot who longed to deliver southern Italy from the tyranny of Spain, that he suffered. Still we may concede that like all the reformers of science he must have aroused the hatred and jealousy of many of the learned, who would doubtless use against him whatever influence they possessed.

Servetus was certainly a learned physician, and is by some ranked as one of the forerunners of Harvey. But his judicial murder by Calvin was due solely to his theological opinions. The merits of Bernard Palissy, not merely as the creator of modern fictile art, but as an able physicist, chemist, and geologist, can not be contested. He shocked the philosophasters and sophists of his day by maintaining that fossil shells were not, as was then supposed, mere freaks of Nature, but the remains of extinct animals. He dared to deny that stones were capable of growth. He pointed out the possibility of artesian wells. With

an almost prophetic insight he foretold the evil consequences of the destruction of forests, and in our day not merely meteorologists and farmers, but governments find that he was in the right. But in spite of all his innovations in science and in industrial art—or rather in consequence of those very innovations—he was honored and protected by Catherine of Medicis and Henry III. That he was at last arrested, condemned to death, and allowed to die in the Bastile, was the consequence of his firm adherence to the doctrines of the Huguenots. Had it not been for his scientific greatness he would have perished earlier.

If Lavoisier perished on the scaffold amid the storms of the first Revolution, he merely shared the fate of his colleagues the *fermiers généraux*, none of whom were men of science. It is true that "the brutish idiot into whose hands the destinies of France had then fallen," as Professor Whewell justly remarks, declared that "the republic had no need of chemists." But these foolish words give us no right to assert, as a modern writer has done, that Lavoisier suffered death for his chemical ideas.

If Bailly likewise perished upon the scaffold, and if Condorcet poisoned himself to escape a similar fate, they died not as philosophers and mathematicians, but as victims of indiscriminate popular frenzy.

There are many other men whose names we are thus compelled to erase from the list of the martyrs of science—men whose inventions and discoveries have been of the highest order, but whose sufferings and death can not be justly looked on as a consequence of their achievements.

But there still remains a third and a too numerous class: thinkers and discoverers who have been persecuted in many cases to the death, not incidentally, but because of the very services they have rendered to science. Their persecutions have differed very much in nature and degree according to the age and the country in which they lived. In the dark ages it was practicable to arrest a troublesome thinker and to put an end to his researches, or at least to their promulgation, by the straightforward means of imprisonment, torture, banishment, and even death at the stake. Hypatia, of Alexandria, was seized by a mob of infuriated monks, who literally tore the flesh from her bones with fragments of pots, dragged her mangled remains outside the city, and there burned them. The Bishop Cyril, who had instigated the outrage, endeavored to screen the malefactors from justice. Virgilius, Bishop of Salzburg, was burned by Boniface, the papal legate, for asserting the existence of antipodes. Cornelius Agrippa, after much persecution, died at last of actual famine. Roger Bacon, perhaps the mightiest philosopher of the middle ages, of whom it has even been said that could he revisit the earth he would shake his head at the slowness of our progress since his death, suffered bitterly. He was first prohibited from lecturing at the University of Oxford and from communicating his researches to any one. The accession of Clemens IV. to the papal

chair gave the illustrious sage a short respite, of which he availed himself to draw up three works, and to publish one of them, the "Opus Majus." Scarcely was this effected when the enlightened Pontiff died, and his successor was indifferent, if not formally hostile. Roger Bacon was summoned to appear at Paris before the legate Jerome of Ascoli, was convicted of heresy and witchcraft, and sentenced to imprisonment for life. His works were also condemned as impious, and all persons were forbidden to read them under pain of excommunication. It is certain that he remained ten years in a loathsome dungeon, and that his treatment, even in that rude age, was considered exceptionally harsh. Some say that he died in prison; others, that he was at length set free at the intercession of certain powerful nobles, and ended his days in England. He is said to lie buried at Oxford. We can wish that ancient university no greater boon than that his spirit may ever rest upon its professors.

Three centuries later Rome witnessed one of the foulest murders ever committed. Giordano Bruno, for upholding the teachings of modern astronomy, and especially for maintaining the immensity of the universe and the plurality of worlds, was burned to death in the Campo di Fiore on February 16, 1600. The words of the sentence passed upon him are significant: "Ut quam clementissime et citra sanguinis effusionem puniretur." Not less memorable was the reply of the hero-philosopher: "You feel more fear in pronouncing this sentence than I do in receiving it!"

One of the greatest merits of Bruno is his enunciation of the doctrine that on all scientific questions the Scriptures neither possess nor claim any authority, but embody merely the opinions current at the times when they were written. This proposition, from which follows as a corollary that the Church can have no claim to pronounce on the truth or falsehood of scientific theories, was afterward enforced at length by Galileo in his celebrated letter to the Dowager Grand Duchess Cristina of Tuscany. We can not help regretting that he, when brought before the inquisitors in the Convent of Minerva, did not act up to his profession by denying *in toto* the authority of the court. Had he done so his life would doubtless have been in great peril, but the enemies of science would have been deprived of much scope for sophistry. "E pur si muove" was well, but "non coram judice" would have been infinitely better. It is worthy of note that, unless we are misinformed, St. Augustine had warned the clergy against the attempt to exercise a jurisdiction over science.

As we approach modern times a change becomes manifest. Ecclesiastical bodies in the more civilized parts of Europe were deprived of civil power, and could no longer imprison, torture, or burn inventors and discoverers. But the old spirit faded away very slowly, and even in our days it still occasionally comes to light. Men of science, scientific works, and learned societies were, and still are, traduced, de-

nounced, and held up to public hatred. Scarcely a capital step has been taken in any branch of research but it has been branded as atheistic. Dean Wren, the father of the celebrated architect, upheld the geocentric theory of the universe and the immovability of the earth in a strain worthy of Caccini or Scioppius. It was objected against the Royal Society that its "members neglected the wiser and more discerning ancients and sought the guidance of their own unassisted judgments, and that by admitting among them men of all countries and religions they endangered the stability of the English Church." It was urged that experimental philosophy was likely to lead to the overthrow of Christianity, and even to atheism. Among these writers a prominent place belongs to Henry Stubbs, of Warwick, and the Rev. Richard Cross, of Somerset, the latter of whom charged the Fellows of the Royal Society with "undermining the universities, destroying Protestantism, and introducing Popery"!

It would have been fortunate for Bruno, Galileo, and not a few of their colleagues, if the Inquisition and the Order of Jesus had taken the same view of the tendency of their researches. The discoveries of Sir Isaac Newton excited an outburst of hostility very similar to that which has in our own times greeted the theory of organic evolution. Then geology became the great bugbear; then followed the nebular hypothesis, till, as we have just hinted, anti-scientific jealousy concentrated itself upon the views of Darwin, Wallace, and their followers. If we read the controversial literature which has issued from the English press within the last half century, and note the motives therein imputed to men of science, we can scarcely doubt what would have been the fate of Buckland, Lyell, Sedgwick, Oken, Carus, Richard Owen, Darwin, had their enemies possessed as much power as malice. It must also be remembered that the practical applications of science and all attempts at its extension among the public have been met with a hostility no less pronounced. Franklin's lightning-conductor and Jenner's discovery of vaccination have been condemned from the pulpit as impious and blasphemous attempts to set aside the decrees of Heaven. A similar condemnation has since been pronounced against the use of anæsthetics, especially in midwifery.

The late Society for the Diffusion of Useful Knowledge, the London University, and the British Association, have each in turn passed through a tempest of abuse. The last-mentioned body, indeed, is still regularly "preached at" in every town which it visits.

In France the Chancellor, D'Aguesseau, refused a license to print Voltaire's "Letters on England," because the author therein expounded the discoveries of Newton, and disproved the vortex theory of Descartes. For adopting Locke's denial of innate ideas, a *lettre de cachet* was issued against Voltaire, and he was compelled to seek safety in flight. More recently the freedom of science seems to be recognized in France, Germany, and even in Italy. We must not,

however, forget that the Roman Church has never formally retracted her claim to adjudicate upon scientific truth. An "Index" of proscribed books is still issued, and within the present century Pope Gregory, in an encyclical letter, characterized the freedom of the press as "deterrima illa ac nunquam satis execranda et detestabilis libertas artis literariæ."

In Britain the anti-scientific spirit still lingers more decidedly than elsewhere. Its chief lurking-places are sometimes said to be among the clergy and country gentlemen. We are not sure that this view is correct. Passing through a street in one of our northern manufacturing towns, the present writer once heard a demagogue addressing a crowd on something which he contended must be put down. That something was science! We are bound to say that his listeners gave every mark of sympathy and approval. The manner in which inventors have often been treated in different parts of England seems to show that such feelings are widely spread. The country which first wins over her working-classes to favor invention and to become themselves inventors will command the industrial supremacy of the world. America is fast attaining this object by her patent system, which enables even a poor man to secure his property in an invention. Our statesmen, Whig and Tory alike, can scarcely be restrained from laying additional difficulties in the way of patent right.

If we now, summing up, seek to know who have been the chief persecutors of science, we shall find the conventional answers too narrow. Many persons have laid the chief blame upon Roman Catholicism. It is very questionable, however, whether other churches, if they had been as widely spread, and had possessed as great civil power and authority, might not have equaled or even exceeded Rome. The religious bodies of Britain, established or dissenting, have certainly been unsurpassed in the virulence of their attacks upon geology and upon the new natural history. We strongly suspect that the Church of Rome will be the first religious body to admit that the doctrines of evolution and of the high antiquity of the human race are not necessarily opposed to the teachings of the Scriptures. So-called infidels of various grades of opinion have contended that Christianity in any and every form is the persecutor of science. We would submit, on the contrary, that discovery was persecuted in heathen and democratic Athens, where all the influence of Pericles barely sufficed to save his friend the philosopher Anaxagoras from a worse fate than banishment. Nay, we may even venture to predict that modern "free-thought" will before long appear as the adversary of Science, and, if sufficiently powerful, as her persecutor.

The jealousy of the industrial classes we have already glanced at.

Lest we should feel tempted to ridicule the suicidal folly of the working-classes in thus seeking to repress improvement, let us remember that Science is sometimes her own persecutor. Men who have

gained a high official position in universities and academies are often actuated by a jealousy very similar to that which we have traced among ecclesiastics. They establish a certain scientific orthodoxy, based often to a great extent on mere conjecture and assertion, and seek to frown down and to silence the unknown outsider who calls in question one of their dogmas, or who discovers a truth which they have overlooked. That any region of research should be officially tabooed is a humiliating circumstance. The dread of truth, the jealousy of discovery, is not confined to the Holy Inquisition, and no disestablishment of churches, no secularization of schools and colleges, not even the suppression of every religion—were such a step possible—would put an end to its action.—*Journal of Science.*

THE PLEASURE OF VISUAL FORM.

By JAMES SULLY.

II.

HAVING thus determined what means of appreciating formal elements and relations are at the command of the eye, our next inquiry will naturally be, What modes of æsthetic intuition—in other words, what intellectual perceptions of pleasing and beautiful relations of form—are possible by help of these means? Fortunately, this side of the subject has been pretty fully investigated already, and I shall be able to pass it over with a very few words.

I here assume, what is agreed on by most writers, that beauty of form—so far as it is independent of sensuous pleasure on the one hand, and pleasures of association and suggestion on the other, is resolvable into the presence of a certain order among manifold details, which order is commonly spoken of as unity in variety. With respect, first of all, to the way in which the element of variety and contrast presents itself in visible form, a word or two will suffice. Direction and magnitude of lines, degree of change of direction, whether appearing as an angle or as a curve, each offers a field for the perception of difference and contrast. And each figure formed by a single arrangement of lines may, in its turn, become an element of variety in a larger scheme. It is worth noting that these elements of variety may be *indefinitely* present to the mind, as in the perception of all relations of distance and direction between points which are not connected by lines. The appreciation of superficial and solid, as distinguished from linear form, clearly involves a countless number of such less definite elements of visual perception.

The study of the various modes of securing a pleasing unity in visual form is a little more intricate. Speaking roughly, one may say

that there are three distinguishable moments or aspects in this unity—namely, continuity of parts one with another; then common correlation with some one dominant element, which is usually the central one; and, finally, similarity and equality of parts. A word or two must suffice in illustrating each of these aspects:

1. We have found a reason for introducing continuity of lines into pleasing form in the nature of ocular movement. Over and above the feeling of smooth transition thus given, a continuous as opposed to a broken arrangement is at once felt to be a unity. The movement of the eye around a contour, to the point from which it set out, yields a peculiar feeling of gratification which may be called a sense of completeness.* The special æsthetic value of contour is seen in the custom of accentuating it in decorative designs by means of ornamental appendages. It is evident that this feeling for the æsthetic value of continuity in form will be developed by experience, which leads us to look on continuity of parts and contour as an essential factor in the unity of objects.

2. Another mode of unity in form closely related to continuity is common connection with one principal element of form, and more particularly with a dominant central feature. For the resting eye, as for the moving, the arrangement of parts about a center has a special value as supplying the most natural mode of percipient activity. Owing, indeed, to the structure of the retina, the center of an object or group of objects is naturally raised to a place of honor.† The eye is instinctively disposed to connect all parts of a design with some central element, and the recognition of such a common connection with a center gives to a design the artistic charm of unity. The most natural central element is, of course, a point, and there are many pleasing forms both in nature and in art which owe a part of their æsthetic value to the presence of such a connecting point. The circular and stellar or radiating forms, the scroll or volute, clearly have this central dominating factor. In many cases, however, the central element is a line or even some simple figure. Thus, all arrangements about an axis, as the forms of trees, flowers, and stems, and all like patterns, are pleasing. In decorative art, again, a central feature is frequently supplied in the shape of some small circle or rectilinear figure.

3. The third aspect of unity, similarity of parts, includes likeness of direction, equality of magnitudes, proportion, etc. All pleasing

* This is strictly analogous to the satisfaction which the ear derives from melodic movement, setting out from a given note (the tonic) and returning to the same.

† It is a distinguishing peculiarity of movements of the eye from the primary position outward, that they are attended by no rolling of the eye about the axis of vision. As a consequence of this, the eye, in tracing lines which radiate from the center of the field (exactly opposite to it), continues to receive the image of the line on the same retinal meridian or series of retinal points, so that at any two successive movements the images partly overlap. This fact speaks for the supreme importance of estimating direction and distance in relation to the center.

forms present similarities of direction, simple and compound, and the characteristic beauty of many forms, both in nature and in art, is traceable in part to the prominence of some one element of direction. Thus the various charms of the forms of cedar and birch among trees, and of the Romanesque and Gothic among architectural styles, are partly due to the predominance of some characteristic feature of form, as the horizontal or drooping line, the rounded or pointed arch.

The sense of equality enters into geometry much more prominently than into visual art; yet it is is not excluded from the latter, it only appears in a more disguised way. All equalities of magnitude among lines, surfaces, etc., are, to speak with Fechner, above the threshold of enjoyment, and the study of art in all its branches shows how considerable this enjoyment is. Among the equalities to which the æsthetically cultivated eye is specially susceptible are those in change of direction, whether angular or curvilinear. In all regular rectilinear figures equality of angle is appreciated as well as that of linear magnitude. The beauty of uniform curves and of undulating lines rests in part on a feeling for this factor of regular and equal change.

That relations of proportion enter into beautiful form is allowed by all. A technically trained eye may recognize, and perhaps enjoy, simple numerical ratios among magnitudes in lines, etc., but this factor does not appear to enter, in a conscious way at least, into ordinary æsthetic appreciation of form. We hardly experience any addition of enjoyment in learning that the ratio of the axes of a pleasing oval is 2 : 1. So far as conscious reflection can tell us, our enjoyment of proportion rests on a vague estimation of one magnitude in relation to another. But, though this relation is not numerically appreciated, it is very exactly estimated. Our enjoyment of the subtile relations of linear magnitude which enter into the beauty of a refined face shows how delicate this quantitative appreciation really is.

It is to be observed, further, that this fine sense of proportion among the various parts of a visible form includes a recognition more or less distinct of an equality between relations of magnitude. And it is this fact which brings the sense of proportion under the head of a feeling for similarity and equality. This is plain enough in the case of all imitative forms. The recognition of a face by means of a miniature portrait is really an example of a very fine perception of equalities of relation, for it rests on a distinct appreciation of the relative linear magnitudes and distances of the several features, and on a perception of the identity of these relations with all changes in absolute magnitude.

It is hardly less certain that the sense of proportion in art, when not thus based on a knowledge of the relations of natural objects, really implies a like recognition of identity of quantitative relations. The enjoyment of a due proportion between the breadth and length of a column, or among the numerous details of a Gothic church, springs

from a recognition of the correspondence of the *perceived* relations with some *conceived* relations, which supply an ideal standard of proportion. This mental standard may repose either on a sense of utility or fitness of parts to a ruling end, on custom, or finally (in the case of the freer forms) on a vague feeling for the relative æsthetic importance of the several features as parts of a pleasing and well-balanced whole. If the eye has this delicate sense for quantitative relation, there is nothing intrinsically unreasonable in the doctrine put forth by Zeising, and partially countenanced by Fechner, that a special æsthetic value belongs to the division of a line into two unequal parts, of which the lesser shall be to the greater as this to the sum of the two or the whole. There is no numerical calculation involved here, and the only question to be asked is whether the eye really does prefer this peculiar division of parts, which Zeising calls "the golden section," and, if so, whether this is due to a sense of the quality of the ratios just named.

That the fact is as Zeising contends seems probable from Fechner's own investigations, in which he compares the different proportions of a large number of commonly recurring forms in ornaments, etc., where there is no apparent need of resorting to one mode of division rather than another. But does it follow that this customary preference involves a conscious comparison of the ratios here specified? In the case of a cruciform ornament, for instance, does the eye, however vaguely, sum together the vertical and horizontal magnitudes in the way supposed? May there not be a reason for choosing this particular division of a whole into parts, besides this hypothetical perception of an equality of ratios? I think there may be. It is noteworthy that, according to Zeising, the dimensions of the human figure illustrate this mode of proportion; and the question naturally arises whether this most frequent and most impressive object of contemplation may not have supplied a norm or ideal standard of proportion, to which we are apt to resort when there is no reason for selecting any other.

These three aspects or moments represent the most abstract principles of unity of form. In practice, these principles commonly combine and blend one with another. This may be seen by a reference to what is known as symmetrical arrangement.

A symmetrical division of parts aims at presenting a number of continuous features under certain aspects of contrast and similarity in relation to some central element. Each element of the design is balanced against some other element opposed to it in direction (that is, from the center), but resembling it in respect of magnitude and distance from the center. It thus supplies a large amount of the element of unity, and is indeed the most regular of all forms.

The most perfectly symmetrical figure is that which is so in respect of each pair of opposite sides or directions, as the rectangle, the polygon with even number of sides, the circle, etc. But such arrangements are apt to be too stiffly regular for art, which, needing abundance of

freedom and variety, usually contents itself with symmetry in one direction, namely, bilateral symmetry. Why symmetry in an horizontal direction should please rather than in a vertical or any other direction will be explained further on.

It may still be objected that I am confounding art and science, and giving to unity and regularity an exaggerated æsthetic importance. This objection will, I think, be largely obviated by the observation, which I have hitherto postponed, that the uniting element is often present in an *ideal* manner only, suggested to the mind rather than directly presented. Thus the continuity of a form has sometimes to be appreciated by help of an ideal completion. For example, a crescent may please the eye because it is so easily expanded by the imagination into a whole circle. Much more frequently does the central element of a design need to be supplied by the mind of the spectator. The beauty of an undulating and of a spiral curve rests in part on a vague representation of the central axis, about which its seemingly free movements arrange themselves in so simple an order. In many symmetrical arrangements, too, as those of the human figure, the central element to which all relations are more or less consciously referred has to be put into the figure by the mind.

The value of such subjectively restored elements of unity is seen in a striking way in the fact that the feeling for order and unity may be satisfied when there is only an approximation to a regular arrangement. The eye, like the ear, can easily bear departures from rigid regularity, if only it is able in a rough and general way to group the details under relations of equality and symmetry. This it does in those freer forms of sculpture and painting which mark a high development of art. Provided this departure of form does not appear to the eye as an error, as a failure to reach perfect exactness—that is to say, provided it is seen to be intended and is felt to be justified—the fact of approximation yields an appreciable enjoyment. The visual imagination here supplements the visual sense, and sees a rightness where the latter alone would see but error.

It is easy to see, by help of this principle, that all the visual arts seek in some degree to satisfy the eye's feeling for form. In some arts, as painting, the element of form is no doubt a good deal subordinated to the exigencies of imitation, and of a wide picturesque variety of detail. Even in sculpture, perfect regularity of form is in the higher stages of art development sacrificed in favor of variety of treatment and natural ease. In truth, the progress of art is largely a progress in freedom of treatment, as we may see by comparing the rigid symmetry of Cimabue with the graceful ease of Raphael, or the stiff regularity of early Greek sculpture with the freedom of the later and better work. Yet, while the principles of form become less conspicuous, they are not wholly abandoned. A Madonna of Raphael may suggest the pyramidical form which an earlier altar-piece so

naïvely forces on our attention. In other words, in the best periods of art, form only disguises itself, becomes more a matter of imaginative reconstruction, and appeals to a finer kind of æsthetic perception. One may add that every now and again the artist will distinctly aim at satisfying the eye's feeling for form by what may almost seem a childish device. Even a Turner does not disdain to please the eye by introducing into his pictures accidental repetitions of form in different objects.*

All good art thus does homage to the principle of form. One may even go further, and say that the characteristic effect of asymmetry, illustrated in many Japanese designs, is really due to a just feeling for form. Like discords and occasional suspensions of tone interval and equal time in music, such irregularities owe their piquancy to the very sense of a law that is broken, though not violently, but, so to speak, in childish freakishness.

In this brief analysis of the direct factor in pleasing visual form, I have regarded the immediate activity of the eye as something ultimate, only referring now and again to the effects of habit in facilitating certain kinds of motor activity. But modern psychological ideas will enable us to explain to some extent how the eye has come to be so constituted as to take pleasure in the kinds of activity just described. There is no room here for more than a brief elucidation of this aspect of the subject.

The doctrine of evolution leads us to view an organ of perception, together with its customary modes of action, as slowly determined by the action of the environment and the needs of practical life. A part of this operation goes on in the individual life, having as its result the selection of the habitual actions as the most easy and most agreeable. A part requires the life of the race for its carrying out, and has for its product a certain innate structure and disposition. The modes of agreeable visual perception illustrate these processes of adaptation to the conditions of practical life. Thus, as I have already hinted in passing, the eye's preference for the horizontal direction, for symmetrical movements of convergence, and so on, may possibly be explained as the result of habits determined by the greater utility of these particular movements. And it is probable, as Wundt suggests, that the innate peculiarities of the eye's mechanism which favor certain kinds of movement, as horizontal, and those from the center of the field, are themselves the result of long processes of racial adaptation.

What applies to the most natural and agreeable modes of ocular movement, applies also to the more pleasurable modes of the higher intellectual appreciation of form. The very feeling for unity of form in any shape is probably related to those deep wants of our existence

* Mr. Ruskin lays great stress on this effect, which he brings under his "Law of Repetition."

which have determined the structure of our intellectual organ to be what it is. And, in the case of the æsthetic value of the several modes of this unity, the action of the environment becomes apparent. Thus, for example, the natural instinct of the cultivated eye to look for a well-marked contour, as well as for a central element of repose, in a design, may be regarded as the result of ingrained habits, determined by the conditions of a distinct visual grasp and recognition of objects in every-day life. So the desire of the eye for proportion seems to be an outgrowth of a habit of attending to relative magnitude, a habit that is clearly connected with the paramount importance of identifying objects at different distances from the eye;* and, as I have already had occasion to observe, the popular preference for certain ratios of magnitude may be due to a habit of making the proportions of the human figure, that most impressive and carefully observed form, a special standard of measurement.

The æsthetic value of symmetry, and more especially bilateral symmetry, illustrates in a striking way this action of the environment and of habit in determining our most pleasurable modes of activity. Mr. Grant Allen has recently remarked on this fact ("Mind," Number XV.), but without any special reference to *bilateral* symmetry. Not only do most organic forms present such a bilateral symmetry, but the forms of inanimate nature, as mountain and valley, show this same relation. The very action of the physical forces determining the configuration of the earth's surface tends to produce a bilaterally symmetrical arrangement, as we may see by the simple experiment of throwing down a heap of pebbles or sand on the ground. Over and above this the ends of support, and the utilities of life in general, serve to give bilateral symmetry a high practical value. Most of the products of the useful arts, from architecture down to the art of constructing common utensils, possess this bilateral symmetry. This prevalence of the relation, in objects of daily perception, would serve to fix a habit of looking for symmetry as the normal form of things. In other words, bilateral symmetry would tend to become, to speak after Kant, a sort of *a priori* form of æsthetic intuition.

But this direct factor is, after all, only one feature of visual form, which, in concrete æsthetic perception, combines with other indirect or associated elements. Over and above the direct action of the environment, and of customary experience in producing an instinctive preference of the eye for some kinds of activity, there is an indirect action of experience in attaching to certain elements and arrangements

* I know a child that, when three years old, at once recognized the faces of several relatives by means of a photograph taken eight years before. The photograph was a *carte-de-visite* group, in which there were just a dozen full-length figures, as well as a good piece of background space. Such a power of appreciating form, shown at so early an age, suggests that there may be an innate disposition to recognize identity by means of equality of relative magnitude.

of form an æsthetic value by reason of associated feelings and ideas. This second great factor in visual form has received a fair amount of attention, and it does not call for more than a hasty reference here.

C. Associated Factor.—So far as forms are strictly non-imitative, and not determined by any needs of fitness to some recognized practical end, the associated factor must reside in certain comparatively abstract qualities. These are in the main resolvable into two classes—those æsthetic aspects which depend on association with touch and movement, and those which involve an idea of human skill.*

If tactual and muscular experiences (other than those of the ocular muscles) are organically embodied into our customary visual perceptions, we shall be prepared to find that the pleasurable side of visual form embraces elements drawn from this region. In truth, all the valued features of form may be said to involve such extraneous experiences. The superior importance of the vertical and horizontal directions, the specially restful character of the horizontal, and the aspiring aspect of the vertical, the voluptuous nature of the curve as opposed to the severity of the straight line, point to the deeper and fuller experiences of movement, muscular exertion, and repose, which we obtain apart from the eye. Even the value of bilateral symmetry for the eye may owe something to that well-marked rhythmic contrast of right and left, which the movements of the tactual organ yield to us. Again, it is easy to see that the various charm of distance, the wooing character of the remote and retiring, and the stimulating aspect of the near and prominent (reflected in a degree in the different effects of convex and concave surface), and the sublime suggestions of great height, all draw their material from experiences of the greater motor organs. So, too, our larger muscular experiences, with their new feeling of resistance and distinct sense of force, furnish elements to our appreciation of fragile grace appearing to ask for support, and of all stability of form. Lastly, the residue of tactile experience (alone or in combination with muscular sense) are traceable plainly enough in the charm of smooth and rounded surface, of that characteristic quality of sculpture which Mr. Ruskin has well called its "bossiness."†

The second class of æsthetically valuable suggestions in the visual perception of form are those of human skill. Man is a constructive animal, and his habits of construction lead him, as Mr. Grant Allen has observed, in the essay already spoken of, to view all forms in nature, as well as in art, in relation to the degree of skill needed to produce them.‡ Thus a perfectly straight line, even in nature, irre-

* A third class of such general and abstract associations might be constituted by the symbolic aspects or the moral and religious suggestions of form (as that of moral rectitude, infinity, etc.), but these are too vague and uncertain to require notice here.

† Herder calls sculpture the art of touch in contradistinction to painting, the art of sight.

‡ This idea of skill will, in the case of the useful arts, take the form of an intuition of a nice adjustment of means to ends, and so become a component element in the sense of fitness.

sistibly calls up a vague consciousness of artistic finish. The peculiar charm of all smaller and more delicate forms rests in part on this vague feeling of fine workmanship. So, too, all perfect regularity and symmetry satisfies this feeling for perfection of handicraft. And, on the other side, departures from regularity, when they suggest the idea of bad workmanship, are, as I have already remarked, distinctly unpleasant.

In addition to these widespread abstract associations with form, there are more circumscribed and concrete associations depending on a vague resemblance to some agreeable natural form. Of these associations the suggestions of human form constitute the most valuable æsthetic element. The supreme interest of the human presence makes us ever ready to see analogies to the human attitude and mode of movement in inanimate nature, and so we fall into the habit of attributing a quasi-human interest to the drooping plant, the stalwart tree rejoicing in its battles with the wind, and the venerable mountain looking down on our lower earth with an expression of Jovian calm. Art, when not distinctly imitative, owes something to these vague suggestions. Thus, we are disposed to transform supporting columns into caryatides before art itself transforms them for us. Next to the human figure, other of the more beautiful organic forms may furnish such associations to the eye. Thus, the Corinthian capital, and forms frequently found in ornamental design, please the eye in part through a vague feeling of their plant-like character.

The reader may perhaps expect us to assign the relative values to these various factors in agreeable form. But psychology is not yet a quantitative science; and, this being so, æsthetics must be content with enumerating the elements, without seeking to measure exactly their relative values. I have insisted on the presence of a direct sensuous element in visual form apart from the pleasures of light and shade. In daily experience we may not be aware of the pleasure which ocular movement in its real or ideal form is fitted to yield, just because our eye usually attends to these movements only as signs of important objective facts. But, when this significance is withdrawn, as in a decorative arabesque design, we may easily become aware of the pleasurable character of such movement. And it must be supposed that this element enters as a very appreciable factor into the whole delight which sculpture and architecture afford us. Even though not a considerable pleasure in isolation from other modes of enjoyment, it may contribute a valuable factor to such a compound æsthetic impression.*

But, though emphasizing these elementary motor experiences of the eye as a factor in agreeable form, I would not exaggerate their importance. It must be remembered that the experiences of touch and

* According to Fechner's principle of æsthetic support, "Vorschule der Æsthetik," p. 50, *et seq.*

extra-ocular movement are inseparably embodied with ocular feelings of movement in the eye's perception even of form elements, and the former are at least equally valuable with the latter. For the rest, I attach much value to the intellectual factor in the appreciation of form—that is, the coördination of numbers of these slightly pleasurable elements under agreeable relations of unity and proportion. Taking the factors just named as the *direct* factor, and contrasting them with the less directly associated elements as the *indirect* factor, I should say that the former decidedly outweighs the latter in what we call beauty of form. Every beautiful form will, I think, be found to owe its charm in the main either to the specially pleasurable character of its elements (ocular or tactual), or to the presence of a large number of distinct aspects of variety and unity. The former is the beauty of simple forms, the latter that of intricate forms.

HYSTERIA AND DEMONISM.*

A STUDY IN MORBID PSYCHOLOGY.

By CHARLES RICHET.

I.

PROBABLY very few persons who have been in Paris have visited the Salpêtrière. A home for old age, an asylum for the insane, are not tempting spectacles, and it pleases us rather than otherwise to be unmindful of the fact that within the great city of Paris is included another city of aged women and mad people, which contains nearly five thousand inhabitants. The Salpêtrière is designed primarily as an abode for infirm old women, and would afford materials for a very curious study of psychology in the observation of the feelings and passions of its inmates to any one desirous of analyzing the effects of age on human intelligence. This study may be attempted some day, but our present purpose is different. Among the insane who are confined in the Salpêtrière are patients who would formerly have been burned, whose disease would have passed for a crime three centuries ago. The study of the malady under which these unfortunates suffer, in its present and past aspects, affords a new and instructive chapter in the history of human thought.

In pursuing the present inquiry, we shall endeavor first to describe the psychological symptoms of hysteria. The knowledge of this disease has received a remarkable development under the careful investigations of the physicians of the Salpêtrière, and it may be that some of the facts they have discovered will interest persons who are not ac-

* Translated from the "Revue des Deux Mondes" by W. H. Larrabee.

quainted with medical science. We shall next inquire into the character of the demoniacal affections which were described in former centuries, and examine the strange succession of errors by which men were led to affirm that the devil took up his lodging in human bodies, and that it was necessary to burn him, to destroy those poor bodies which had become the receptacles and accomplices of malevolent spirits. Lastly, we shall review the history of the great trials for witchcraft in the sixteenth and seventeenth centuries. A chronological order would require that we should begin with the notice of demonism in the past, and close with the study of the corresponding affections of the present, but the reverse is the logical order. We shall follow with more interest the relation of the superstitions which led our ancestors astray, after we have become better acquainted with the facts that have been elucidated by contemporary investigators. In order to be able to judge error aright, we must first be acquainted with the truth.

An erroneous opinion prevails as to the causes and nature of hysteria. Romancers, particularly those who call themselves naturalists, have not neglected to propagate the doctrine that hysteria is an erotic disease. This is far from being exact. There is no relation of cause and effect between hysteria and celibacy; and we can speak of hysteria, study its causes, and describe its symptoms without infringing upon delicacy. It is a nervous disease, which has no more to do with sexual passion than other nervous diseases, and, notwithstanding the dread which it excites in half-instructed persons, we can say boldly that that dread is not justified. The facts that prove this point will appear shortly.

The asylum for the insane at the Salpêtrière is behind the buildings which are inhabited by the aged women. The hysterical patients are confined here. They are collected together in one part of the hospital, and have been for several years under the care of M. Professor Charcot. This learned physician, being desirous of applying to the nervous affections the exact methods which are employed in physiology, has established near the halls reserved for the patients a laboratory where precise studies of the most delicate phenomena of the pathology of the nervous system may be carried on. A photographic room is attached to the laboratory, in which exact representations of the principal phases of the attacks of hysteria, epilepsy, and somnambulism, have been obtained.* In this manner we have succeeded in securing minute descriptions of a class of psychological phenomena so strange and fantastic that, hardly more than three centuries ago, men saw in them the breath of the devil and of all the demons of hell.

Some persons may be surprised to learn that hysterical patients are

* These photographs, which are very instructive in the study of nervous diseases, form the publication of MM. Bourneville and Regnard, entitled "Iconographie photographique de la Salpêtrière."

confined in the Salpêtrière, for it has not been usual to regard hysteria as a grave disease necessitating or justifying seclusion. It is not always so grave. The disease manifests itself in every degree. Just as we may suffer a burn that is so superficial that we can hardly feel it, while there are other burns so deep and extended that they lead to death; just as there are light fevers and also fevers that are speedily mortal—so there are light hysteriæ, almost imperceptible, constituting a disposition of the organization rather than a disease, and besides them there are grave hysteriæ, so grave that they are confounded with insanity, with general paralysis, and with epilepsy. At the Salpêtrière, there are hardly any other hysterical cases than those of grave hysteria; as to light hysteria, it may be found everywhere. When the doctors speak of a nervous woman, they say an hysterical woman; and this language, though it may sound unpleasantly in a conversation or a romance, is not out of place in a psychological study, for what is commonly called nervousness in a young woman is simply hysteria.

I imagine that every one is more or less acquainted with the oddities of character exhibited by nervous women. All their feelings are carried to an extreme. The most trifling event is enough to provoke enthusiasm or despair in them. Nobody can cry so easily. It even seems to me that they control the fountain-key of tears, at least so as to make them flow, for to put a stop to them is another affair. To say that hysterical persons will cry for a small matter is saying too little, for they will cry for nothing; they will be all of a sudden possessed of an indefinable grief, an incomprehensible, vague sorrow, which it is not possible to resist. It is like a ball that rises from the chest to the throat, hinders respiration, and causes suffocation. They must retire, hide themselves in the most obscure corner, and there, where they are not seen or heard, sob for hours; then, suddenly, the fit of sorrow will cease and give place to a surprising gayety.

All that it has been customary to attribute to the nervous temperament of woman enters into the domain of hysteria. The appetite is capricious, fantastic: to-day, for example, everything displeases, and it is impossible to accept a particle of nourishment; to-morrow, all will be changed and nothing will suffice to appease the hunger. Generally, hysterical persons have a marked taste for vinegar and green fruits—a diet certainly not favorable to health. Such irregular and deficient alimentation impedes general nutrition and impoverishes the blood, and, by a kind of circular connection of disorders which is very common in pathology, the anæmia thus induced augments the hysteria which is the occasion of it; and young women suffering from it are more subject to hysteria than others.

As every one knows, the character of hysterical persons is very strange. We might say, borrowing an expression from the painters, that it is very picturesque, and presents points of view varied and always unforeseen. A young woman, for example, who yesterday had

a charming disposition, was docile and amiable, is wholly changed to-day. She will not endure the least observation, is discontented with everything, has a bad look for everybody, breaks all rules, and is quite ungovernable. Her indocility is the more surprising, because it arises suddenly without cause, and disappears in the same manner. Self-love is always extravagantly developed. The most trifling pleasantry often becomes a cruel offense, to be borne with indignation, which tears enough can not be shed to protest against. Everything becomes the subject of a drama. Existence appears like a scene in a theatre. The regular, quiet life of every-day routine is transformed by the hysterical woman into a series of grave events, adapted to all sorts of dramatic developments. The hysterical sufferers continually play with an equal success at tragedy and comedy amid the flat scenes of reality. They can not comprehend simplicity in life, but make life a complication. Terror, jealousy, joy, anger, love, everything is exaggerated out of proportion with the just and measured feelings which are becoming.

Every human being, I believe, is moved by two opposing forces, sentiment and will. With the will we succeed (or think we succeed, which amounts to the same thing) in taming the feelings, in silencing the instinctive and passionate exuberance of the brute nature, we become masters of ourselves, *compos sui*, as the ancients said. We know that it is good to tell this, to conceal that, that there are noble sentiments and base passions, that we ought to obey the former and crush the latter. Hysterical persons do not know this, they do not comprehend what is meant by the power of ruling the passions. Passion leads them, and they suffer themselves to be carried where passion takes them. If the wind of anger or jealousy blows, they give themselves up, without opposition, to anger or jealousy; if it is the wind of charity or obedience, they are charitable or obedient. If the fancy to say what is impertinent or incongruous crosses their brain, the impertinent or incongruous saying is uttered. They are somewhat like persons who have taken hasheesh, and float off on the waves of fancy or enthusiasm.

We can never know how to depend on the feelings of an hysterical person. Any attempt to forecast them would be rash, and we may have equally good reasons to expect to find her well disposed or discontented. Her feelings will be likewise of the most fleeting character, and she will not imagine that it is necessary to establish transitions between laughing and tears, anger and satisfaction. Her bad humor will last while you turn an hour-glass, and she will behave like children who burst out in laughing while the tears they have just shed are still rolling down their cheeks.

Notwithstanding this mobility, this irresistible spontaneity, the victims of hysteria are wholly wanting in sincerity. They are all more or less liars; not so much, perhaps, that they are ready to tell selfish

lies as that they indulge themselves in forging useless ones. They seem to have a love for lying, or rather for imposture. Nothing pleases them better than to lead those who question them into error; to relate stories that are absolutely false, which have not a shadow of probability; to give an account of all that they have not done and all that they have done, with an incredible luxury of details. These wanton lies are told boldly, bluntly, with a coolness that disconcerts. The physician who examines hysterical patients has always to bear in mind that they intend to deceive him, to hide the truth, and feign things that do not exist, as well as to disguise things that do exist.

Let us see now how hysteria differs from insanity. In insanity the intelligence is deeply affected, while hysteria is rather a form of disposition than a disease of the intellect. Hence the psychological interest of the hysterical condition. The apprehension is brilliant, the memory sure, the imagination lively. The defective side of the mind is revealed only by the impotency of the will to restrain passion. The will seems, in fact, to be the most delicate mechanism in the mental organization; and, when a poisonous substance enters the system to trouble the intellectual faculties, it always begins by suppressing the influence of the will over the passions.

Hysteria in its light form is of frequent occurrence. The causes that determine it ought then to be very common. One of the principal ones is heredity. If the father or mother has a nervous temperament, the daughter will probably be predisposed to hysteria. The sense of the word "heredity" as used here should be rightly understood. It is not necessary that the same form of affection shall appear in the parents and the children. A nervous derangement in the parents may be reproduced in the children under different aspects. For example, an epileptic father may have an idiotic son, an insane son, and an hysterical daughter. The law of hereditary liability is equally true when, instead of a nervous malady as grave as epilepsy or insanity, we have to do simply with a nervous temperament. Just as the color of the hair, the shape of the nose, and the voice are similar in parents and children, so the temperament is transmitted from one generation to another. The results of the medical observations of several centuries agree with the common opinion. In the times of witchcraft, the daughter of a witch—that is to say, of a person afflicted with hysteria—was inevitably regarded as a witch, and there was no need of seeking other motives for an accusation.

Other accessory causes supplement the preponderant influence of heredity. A girl, brought up with a certain degree of culture, who sees around her persons that were her companions in other days in a better situation than she has been able to reach, will become hysterical because fortune has not given her the enjoyments she craves. Dreams that have been dispelled, illusions that have vanished, hopes that have proved to be chimerical, afford motives almost sufficient to

give rise to the affection. Thus hysteria is common in Paris and other large cities where girls of the lower and middle classes receive an education superior to their social condition. Such girls seldom find the ideal husband of whom they have dreamed. Marriage affords them no relief from the sordid difficulties that occur daily, and the narrow cares of the household afford an insufficient satisfaction to the vast aspirations of a disordered imagination. Misery, want, grief, etc., often cause the symptoms of hysteria to appear in girls and young women who have only a slight predisposition to it. To sum it all up, hysteria has a physiological cause—heredity; and a social cause—the inferiority of the reality to the dream.

Light hysteria is not a true disease. It is one of the varieties of the female character. We might say that hysterical persons are women more than other women. They have lively and transient feelings, brilliant and variable fancies, and, withal, inability to bring their feelings and fancies under the rule of reason and judgment. The novelists have appreciated the advantage which they could derive from the study of this form of character, and have given us numerous pictures of attacks of hysteria, and of women who were subject to them. Their efforts have not always been fortunate, but occasionally they furnish exact descriptions which complement what we have just said respecting the psychical state of nervous women.

M. Octave Feuillet makes the husband of a woman who suffers from hysteria speak in a manner that, without pronouncing the word, projects the symptoms of the affection so plainly that there can be no mistake in the diagnosis. Thus: "That woman of the world," said M. de Marsan, "has suddenly borrowed from the prisoners a set of bitter, curt, desperate phrases, like those we may read on the walls of the cells. That woman of sense has all at once given herself up to the reading of the least reserved poets and novelists. . . . I inspire with terror from her elocution, formerly so sober, some insipid poetic perfume. At other times we might say she had fallen back into childhood, so nice and finical has become the turn of her conversation. She adds to it the movements of a little girl; then all at once her language, just now modest almost to puerility, breaks out into the most indelicate flashes, into curiously improper expressions. She passes without transition from the style Rambouillet and the Byronic paraphrase to the coarse language of the fish-woman, and this without preparation, provocation, or excuse. At the same time, the woman, the wife, the mother, is transformed. The husband has assumed the proportions of a tyrant, and the children seem to have become a burden."

The last observation is true to the life. Nothing is more common than to see a nervous woman, till now tender to her husband and children, take a sudden disaffection or even a hatred against them. The aversion manifested in such cases may be provoked by the most futile causes, as, any insignificant external object, the shape of the beard,

the watch-charms, a drawl in the tone of the voice, a habit of repeating the same word. It would be hard to invent deliberately such whimsical reasons as hysterical women are capable of imagining to explain the aversion they conceive for certain persons. The unfortunate person thus detested is most likely to be the husband.

M. A. France says of one of his heroines, that "she was pleasant, indolent, fastidious, subject to gushes of affection, and of quick sympathies. They had trouble in the refectory in making her eat anything but salads and bread with salt. She made a friend with whom she went on the days-out. This friend, who was rich, took Helen into the tapestried room, where she crunched *bonbons*. Helen lingered in this nest of goods. When she came out, all seemed dull, hard, repellent. She had lost courage; she dreamed of having a blue chamber, and of reading romances in it lying in an easy-chair. Pains of the stomach came on and cast her down completely. . . . She gave up, indifferent to everything around her, dreaming of jewels, dresses, horses, sailing, and going into tears at the mere thought of her father."

MM. E. and J. de Goncourt have related the touching, sad story of poor Germinie Lacerteux. She was indeed a victim of hysteria; of an untaught nature, passionate, ardent in devotion as in infamy; of weak intelligence besides, the blind plaything of passions of which she was hardly conscious, and which moved her as the winds turn a vane. "Germinie had not a consciousness that could escape suffering by brutishness and that dense stupidity in which a woman may vegetate in simple inanity. A sickly sensitiveness, a head always busy, cherishing grief, inquietude, discontent with herself, a moral sense which seemed to rise in her again after each of her faults, all the gifts of delicacy, and the capacity of suffering were united in her to torture her." To feel, to think, to have no will, these are the three miseries with which the poor sufferers from hysteria have to struggle.

M. Albert Delpit has thus depicted the symptoms of hysteria in his "Mariage d'Odette": "She was seized with a fit of melancholy, to which succeeded violent spasms of crying and immoderate bursts of laughter; sometimes she would shake with tremors from head to foot; then she grew pale and felt an oppression at her chest. Her temper underwent an entire change. They had to give up taking her into society, its too free manners were so startling to her."

The most life-like hysterical character delineated by the novelists, the truest, the most passionate, is Madame de Bovary. Brought up in a convent, among girls richer than herself, she married a country doctor—a poor, weak youth, whose rusticity and poverty disheartened her. M. Flaubert has described her hysteria in a few lines with scientific precision and artistic distinctness: "Emma became hard to please, capricious; she ordered dishes for herself and would not touch them; one day she would drink nothing but pure milk, and the next coffee by the dozen cups. Sometimes she would persist in refusing to go

out, then would think she was suffocating, would open the windows and put on a light dress. . . . She ceased to conceal her contempt for any thing or any person, and frequently assumed to express singular opinions—condemning what is approved, and approving wrong or immoral things. Must this misery last always? Will she never escape it? Yet she was worth as much as those who lived happily, and she execrated the injustice of God. She rested her head on the walls to cry. She envied those who led tumultuous existences, and longed for nights of masking and insolent pleasures with all the distractions she knew nothing of and which they could give. . . . She grew pale and had beatings of the heart. . . . On some days she would indulge in a feverish profusion of boasting. . . . To these indulgences succeeded immediately spells of torpor in which she would rest without speaking, without stirring. She bought a Gothic *prie-Dieu*, and spent fourteen francs in one month for lemons to clean her nails. She selected the handsomest of his scarfs from Lheureux's, tied it over her wrapper, and, having closed the shutters, lay in this garb upon the sofa with a book in her hand. She thought she would learn Italian, and bought dictionaries, a grammar, and white paper. She tried serious reading, history, philosophy. . . . She had fits when she could be readily pushed to extravagances. She insisted one day to her husband that she could drink half a glass of brandy, and, when Charles was foolish enough to challenge her to do it, she swallowed the brandy to the last drop."

We seem to be far away from the demoniacs, but we are not. We can observe all the transitions between light hysteria like that of Madame Bovary and grave hysteria like that of the patients in the Salpêtrière. All the symptoms of the light form exist likewise in the grave form, but they are stronger and more durable. We need not return to them. Other symptoms, special to grave hysteria and serving to characterize it, are anæsthesia, total or partial, convulsive attacks, and delirium.

BACTERIA AS DESTROYERS OF INSECTS.

By E. RAY LANKESTER, F. R. S.

"WHAT is the good of a knowledge of microscopic creatures? What is the good of prying into the anatomy of insects? It is all very well as an amusement, but serious persons can not be expected to assent to the devotion of endowments or state funds to such trivial purposes. Chemistry, geology, electricity, if you please, have their solid commercial value, but biology is an amusement for children and old gentlemen." Such is the opinion of many a "practical man," ignorant and short-sighted as the genus invariably proves itself.

Already the practical man may be told, in reply, that surgery is entirely reformed by our knowledge of the minuter fungi; that, by avoiding the access of bacteria to wounds, we avoid a large destruction of human life. Already we see our way to avoiding some deadly diseases caused by these same bacteria now that we know them to be the active cause of such disease. Already silk is cheaper in consequence of our knowledge of the bacteria of the silk-worm disease; already better beer is brewed and better yeast supplied to the baker in consequence of Pasteur's discovery of the bacterian diseases of the yeast-plant; already vinegar-making, cheese-making, butter-making, wine-making, and other such manufacturing trades are on the way to benefit by like knowledge. Potato-disease and coffee-disease have been traced to their causes and means suggested by biologists for dealing with the parasitic plants causing those diseases, whereby not thousands but millions of pounds sterling a year may be saved to the community.

Insect-pests which have depopulated whole provinces, such pests as the phylloxera and the Colorado beetle, are about to receive a check at the hands of the same class of scientific students. The application of knowledge of natural facts is in this case a very remarkable one; for it is actually proposed to make use of our recently acquired knowledge of diseases due to bacteria—not that we may arrest such diseases, but that we may promote them. Insect-pests are to be destroyed by poisoning them not with acrid mineral poisons which damage plants as well as the insects, but by encouraging the spread of the disease-producing bacteria which are known to be fatal to such insects. Professor Hagen, of Cambridge, Massachusetts, has called attention to the old practice of destroying greenhouse pests by the application of yeast. He conceives that this method may be applied to other insect-pests, such as phylloxera, Colorado beetle, cotton-worm, etc. He imagines that the yeast-fungus enters the body of the insect on which it is sprinkled, and there produces a growth which is fatal to the insect's life. It is a well-known fact that insects are very subject to fungoid diseases, and it is also ascertained that the application of yeast to the plants frequented by such insects favors their acquisition of such disease. Professor Elias Metschnikoff, the celebrated embryologist has, however, made some investigations on this subject, and given an explanation of the possible value of yeast application ("Zool. Anzeiger," No. 47), different and more satisfactory than that which Professor Hagen appears to adopt.

The general result of the most accurate investigations of the beer-yeast fungus (*Saccharomyces cerevisiæ*) is entirely opposed to the notion that it can enter an insect's body and produce a disease. Beer-yeast is beer-yeast and appears always (or within experimental limits) to remain so. On the other hand, De Bary has made known the life-history of some simple fungi which destroy insects, and from Pasteur, Cohn,

and others we know of diseases due to those simplest of fungi, the bacteria, which produce the most deadly ravages among insects. Professor Metschnikoff has examined some of these minute parasitic fungi and cultivated them by passing them from one insect to another, and has experimentally proved their very deadly character to the insects exposed to infection. The "green muscardine" (*Isaria destructor*) is the name given by Metschnikoff to one of the minute fungi the effects of which he most successfully traced. Now, it is perfectly evident that if green muscardine spores could be produced in large quantity, or spores of similar disease-producing fungi, and applied to the ground and shrubs infested by insect-pests liable to harbor those fungi, we should have the best of all means for effecting the destruction of the insects, viz., a poison which once set at work would spontaneously multiply and spread its destroying agents around.

Accordingly, Professor Metschnikoff endeavored to cultivate the "green muscardine" apart from insects, so as to obtain its spores if possible in great quantity, in a liquid which might be applied to places attacked by injurious insects. He at last succeeded in effecting this cultivation by the use of beer-mash; in this decoction the "green muscardine" produced a rich mycelium and finally spores.

It is exceedingly probable that we have here the true explanation of the value of the application of yeast to plants, etc., affected by insect-pests. If there are a few spores only of such parasites as the "green muscardine" about, the fluids of the yeast will serve them for nourishment and so cause the muscardine to spread until it comes into contact with the insects. There is no reason to suppose that the beer-yeast plant itself is capable of generating a disease in any insects; at the same time we must remember that yeast as ordinarily used by the brewer is by no means pure: it contains in small quantities other minute fungi besides the *Saccharomyces cerevisiæ*, and it is quite possible that a given quantity of it, say a pint, *may*, if the brewery from which it came were not conducted on the most perfect system (such as that lately introduced by Pasteur), contain a few spores of such a disease-producing parasite as muscardine. A diseased insect once in a way falling into the mash-tub would sufficiently keep up the supply, and thus it is possible that yeast may carry infection to insect-pests and destroy them.

At the same time, Professor Metschnikoff's suggestion of a deliberate cultivation of an insect's disease-producing fungus, and the application of the cultivated fungus in quantity to places infested by these insects, is in the highest degree ingenious, and likely to give results the value of which will be estimated in thousands of pounds, and so do something to persuade "practical" men that all science is deserving of their respect and encouragement.—*Nature.*

SOME FACTS AND FICTIONS OF ZOÖLOGY.

By Dr. ANDREW WILSON.

WHEN the country swain, loitering along some lane, comes to a standstill to contemplate, with awe and wonder, the spectacle of a mass of the familiar "hair-eels" or "hair-worms" wriggling about in a pool, he plods on his way firmly convinced that, as he has been taught to believe, he has just witnessed the results of the transformation of some horse's hairs into living creatures. So familiar is this belief to people of professedly higher culture than the countryman, that the transformation just alluded to has to all, save a few thinking persons and zoölogists, become a matter of the most commonplace kind. When some quarrymen, engaged in splitting up the rocks, have succeeded in dislodging some huge mass of stone, there may sometimes be seen to hop from among the *débris* a lively toad or frog, which comes to be regarded by the excavators with feelings akin to those of superstitious wonder and amazement. The animal may or may not be captured; but the fact is duly chronicled in the local newspapers, and people wonder for a season over the phenomenon of a veritable Rip Van Winkle of a frog, which, to all appearance, has lived for "thousands of years in the solid rock." Nor do the hair-worm and the frog stand alone in respect of their marvelous origin. Popular zoölogy is full of such marvels. We find unicorns, mermaids, and mermen; geese developed from the shell-fish known as "barnacles"; we are told that crocodiles may weep, and that sirens can sing—in short, there is nothing so wonderful to be told of animals that people will not believe the tale; while, curiously enough, when they are told of veritable facts of animal life, heads begin to shake and doubts to be expressed, until the zoölogist despairs of educating people into distinguishing fact from fiction, and truth from theories and unsupported beliefs. The story told of the old lady, whose youthful acquaintance of seafaring habits entertained her with tales of the wonders he had seen, finds, after all, a close application in the world at large. The dame listened with delight, appreciation, and belief, to accounts of mountains of sugar and rivers of rum, and to tales of lands where gold and silver and precious stones were more than plentiful. But, when the narrator descended to tell of fishes that were able to raise themselves out of the water in flight, the old lady's credulity began to fancy itself imposed upon; for she indignantly repressed what she considered the lad's tendency to exaggeration, saying, "Sugar mountains may be, and rivers of rum may be, but fish that flee ne'er can be!" Many popular beliefs concerning animals partake of the character of the old lady's opinions regarding the real and the fabulous; and the circumstance tells powerfully in

favor of the opinion that a knowledge of our surroundings in the world and an intelligent conception of animal and plant life should form part of the school-training of every boy and girl.

The tracing of myths and fables is a very interesting task, and it may, therefore, form a curious study, if we endeavor to investigate very briefly a few of the popular and erroneous beliefs regarding lower animals. The belief regarding the origin of the hair-worms is both widely spread and ancient. Shakespeare tells us that—

> " . . . . much is breeding
> Which, like the courser's hair, hath yet but life,
> And not a serpent's poison."

The hair-worms certainly present the appearance of long, delicate black hairs, which move about with great activity amid the mud of pools and ditches. These worms, in the early stages of their existence, inhabit the bodies of insects, and may be found coiled up within the grasshopper, which thus gives shelter to a guest exceeding many times the length of the body of its host. Sooner or later the hair-worm, or *Gordius*, as the naturalist terms it, leaves the body of the insect, and lays its eggs, which are fastened together in long strings, in water. From each egg a little creature armed with minute hooks is produced, and this young hair-worm burrows its way into the body of some insect, there to repeat the history of its parent. Such is the well-ascertained history of the hair-worm, excluding entirely the popular belief in its origin. There certainly does exist in science a theory known as that of "spontaneous generation," which, in ancient times, accounted for the production of insects and other animals by assuming that they were produced in some mysterious fashion out of lifeless matter. But not even the most ardent believer in the extreme modification of this theory, which holds a place in modern scientific belief, would venture to maintain the production of a hair-worm by the mysterious vivification of an inert substance such as a horse's hair.

The expression "crocodile's tears" has passed into common use, and it therefore may be worth while noting the probable origin of this myth. Shakespeare, with that wide extent of knowledge which enabled him to draw similes from every department of human thought, says that—

> " . . . . Gloster's show
> Beguiles him, as the mournful crocodile
> With sorrow snares relenting passengers."

The poet thus indicates the belief that not only do crocodiles shed tears, but that sympathizing passengers, turning to commiserate the reptile's woes, are seized and destroyed by the treacherous creatures. That quaint and credulous old author—the earliest writer of English prose—Sir John Maundeville, in his "Voiage," or account of his "Travaile," published about 1356—in which, by the way, there are

to be found accounts of not a few wonderful things in the way of zoölogical curiosities—tells us that in a certain "contre and be all yonde, ben great plenty of Crokodilles, that is, a manner of a long Serpent as I have seyd before." He further remarks that "these Serpents slew men," and devoured them, weeping; and he tells us, too, that "whan thei eaten thei meven (move) the over jowe (upper jaw), and nought the nether (lower) jowe: and thei have no tonge (tongue)." Sir John thus states two popular beliefs of his time and of days prior to his age, namely, that crocodiles moved their upper jaws, and that a tongue was absent in these animals.

As regards the tears of the crocodiles, no foundation of fact exists for the belief in such sympathetic exhibitions. But a highly probable explanation may be given of the manner in which such a belief originated. These reptiles unquestionably emit very loud and singularly plaintive cries, compared by some travelers to the mournful howling of dogs. The earlier and credulous travelers would very naturally associate tears with these cries, and, once begun, the supposition would be readily propagated, for error and myth are ever plants of quick growth. The belief in the movement of the upper jaw rests on an apparent basis of fact. The lower jaw is joined to the skull very far back on the latter, and the mouth-opening thus comes to be singularly wide; while, when the mouth opens, the skull and upper jaw are apparently observed to move. This is not the case, however; the apparent movement arising from the manner in which the lower jaw and the skull are joined together. The belief in the absence of the tongue is even more readily explained. When the mouth is widely opened, no tongue is to be seen. This organ is not only present, but is, moreover, of large size; it is, however, firmly attached to the floor of the mouth, and is specially adapted, from its peculiar form and structure, to assist these animals in the capture and swallowing of their prey.

One of the most curious fables regarding animals which can well be mentioned is that respecting the so-called "bernicle" or "barnacle geese," which by the naturalists and educated persons of the middle ages were believed to be produced by those little crustaceans named "barnacles." With the "barnacles" every one must be familiar who has examined the floating drift-wood of the sea-beach, or who has seen ships docked in a seaport town. A barnacle is simply a kind of crab inclosed in a triangular shell, and attached by a fleshy stalk to fixed objects. If the barnacle is not familiar to readers, certain near relations of these animals must be well known, by sight at least, as among the most familiar denizens of our seacoasts. These latter are the "sea-acorns" or *Balani*, whose little conical shells we crush by hundreds as we walk over the rocks at low-water mark; while every wooden pile immersed in the sea becomes coated in a short time with a thick crust of these "sea-acorns." If we place one of these little animals, barnacle or acorn—the latter wanting the stalk of the former

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—in its native waters, we shall observe a beautiful little series of feathery plumes to wave backward and forward, and ever and anon to be quickly withdrawn into the secure recesses of the shell. These organs are the modified feet of the animal, which not only serve for sweeping food-particles into the mouth, but act also as breathing-organs. We may, therefore, find it a curious study to inquire through what extraordinary transformation and confusion of ideas such an animal could be credited with giving origin to a veritable goose; and the investigation of the subject will afford a singularly apt illustration of the ready manner in which the fable of one year or period becomes transmitted and transformed into the secure and firm belief of the next.

We may begin our investigation by inquiring into some of the opinions which were entertained on this subject and ventilated by certain old writers. Between 1154 and 1189 Giraldus Cambrensis, in a work entitled "Topographia Hiberniæ," written in Latin, remarks concerning "many birds which are called *Bernacæ:* against nature, nature produces them in a most extraordinary way. They are like marsh geese, but somewhat smaller. They are produced from fir-timber tossed along the sea, and are at first like gum. Afterward they hang down by their beaks, as if from a sea-weed attached to the timber, surrounded by shells, in order to grow more freely." Giraldus is here evidently describing the barnacles themselves. He continues: "Having thus, in process of time, been clothed with a strong coat of feathers, they either fall into the water or fly freely away into the air. They derive their food and growth from the sap of the wood or the sea, by a secret and most wonderful process of alimentation. I have frequently, with my own eyes, seen more than a thousand of these small bodies of birds, hanging down on the seashore from one piece of timber, inclosed in shells, and already formed." Here, again, our author is speaking of the barnacles themselves, with which he naturally confuses the geese, since he presumes the crustaceans are simply geese in an undeveloped state. He further informs his readers that, owing to their presumably marine origin, "bishops and clergymen in some parts of Ireland do not scruple to dine off these birds at the time of fasting, because they are not flesh, nor born of flesh," although, for certain other and theological reasons, Giraldus disputes the legality of this practice of the Hibernian clerics.

In the year 1527 appeared "The Hystory and Croniclis of Scotland, with the cosmography and dyscription thairof, compilit be the noble Clerk Maister Hector Boece, Channon of Aberdene." Boece's "History" was written in Latin, the title we have just quoted being that of the English version of the work (1540), which title further sets forth that Boece's work was "Translatit laitly in our vulgar and commoun langage be Maister Johne Bellenden, Archedene of Murray, And Imprentit in Edinburgh, be me Thomas Davidson, prenter to the

Kyngis nobyll grace." In this learned work the author discredits the popular ideas regarding the origin of the geese. "Sum men belevis that thir clakis (geese) growis on treis be the nebbis (bills). Bot thair opinioun is vane. And becaus the nature and procreatioun of thir clakis is strange, we have maid na lytyll laboure and deligence to serche ye treuth and verite yairof, we have salit (sailed) throw ye seis quhare thir clakis ar bred, and I fynd be gret experience, that the nature of the seis is mair relevant caus of thair procreatioun than ony uthir thyng." According to Boece, then, "the nature of the seis" formed the chief element in the production of the geese, and our author proceeds to relate how "all treis (trees) that ar cassin in the seis be proces of tyme apperis first wormeetin (worm-eaten), and in the small boris and hollis (holes) thairof growis small worms." Our author no doubt here alludes to the ravages of the *Teredo*, or ship-worm, which burrows into timber, and with which the barnacles themselves are thus confused. Then he continues, the "wormis" first "schaw (show) thair heid and feit, and last of all thay schaw thair plumis and wyngis. Finaly, quhen thay ar cumyn to the just mesure and quantite of geis, thay fle in the aire as othir fowlis dois, as was notably provyn, in the yeir of God ane thousand iii hundred lxxxx, in sicht of mony pepyll, besyde the castell of Petslego." On the occasion referred to, Boece tells us that a great tree was cast on shore and was divided, by order of the "lard" of the ground, by means of a saw. Wonderful to relate, the tree was found not merely to be riddled with a "multitude of wormis," throwing themselves out of the holes of the tree, but some of the "wormis" had "baith heid, feit and wyngis," but, adds the author, "thay had no fedderis (feathers)."

Unquestionably either the scientific use of the imagination had operated in this instance in inducing the observers to believe that in this tree, riddled by the ship-worms, and possibly having barnacles attached to it, they beheld young geese; or Boece had construed the appearances described as those representing the embryo-stages of the barnacle-geese.

Boece further relates how a ship named the Christofir was brought to Leith, and was broken down because her timbers had grown old and failing. In these timbers were beheld the same "wormeetin" appearances, "all the hollis thairof" being "full of geis." Boece again most emphatically rejects the idea that the "geis" were produced from the wood of which the timbers were composed, and once more proclaims his belief that the "nature of the seis resolvit in geis" may be accepted as the true and final explanation of their origin. A certain "Maister Alexander Galloway" had apparently strolled with the historian along the seacoast, the former giving "his mynd with maist ernist besynes to serche the verite of this obscure and mysty dowtis." Lifting up a piece of tangle, they beheld the sea-weed to be hanging full of mussel-shells from the root to the branches. Maister Galloway

opened one of the mussel-shells, and was "mair astonist than afore" to find no fish therein, but a perfectly-shaped "foule, smal and gret" as corresponded to the "quantity of the shell." And once again Boece draws the inference that the trees or wood on which the creatures are found have nothing to do with the origin of the birds; and that the fowls are begotten of the "occeane see, quhilk," concludes our author, "is the caus and production of mony wonderful thingis."

More than fifty years after the publication of Boece's "History," old Gerard of London, the famous "master in chirurgerie" of his day, gave an account of the barnacle-goose, and not only entered into minute particulars of its growth and origin, but illustrated its manner of production by means of the engraver's art of his day. Gerard's "Herball," published in 1597, thus contains, among much that is curious in medical lore, a very quaint piece of zoölogical history. He tells us that "in the north parts of Scotland, and the Ilands adjacent, called Orchades (Orkneys)," are found "certaine trees, whereon doe growe certaine shell fishes, of a white colour tending to russet; wherein are conteined little living creatures: which shels in time of maturitie doe open, and out of them grow those little living foules whom we call Barnakles, in the north of England Brant Geese, and in Lancashire tree Geese; but the other that do fall upon the land, perish, and come to nothing: thus much by the writings of others, and also from the mouths of people of those parts, which may," concludes Gerard, "very well accord with truth."

Not content with hearsay evidence, however, Gerard relates what his eyes saw and hands touched. He describes how on the coasts of a certain "small Ilande in Lancashire called Pile of Foulders" (probably Peel Island), the wreckage of ships is cast up by the waves, along with the trunks and branches "of old and rotten trees." On these wooden rejectamenta "a certaine spume or froth" grows, according to Gerard. This spume "in time breedeth unto certaine shels, in shape like those of the muskle, but sharper pointed, and of a whitish colour." This description, it may be remarked, clearly applies to the barnacles themselves. Gerard then continues to point out how, when the shell is perfectly formed, it "gapeth open, and the first thing that appeereth is the foresaid lace or string"—the substance described by Gerard as contained within the shell—"next come the legs of the Birde hanging out; and as it groweth greater, it openeth the shell by degrees, till at length it is all come foorth, and hangeth only by the bill; in short space after it commeth to full maturitie, and falleth into the sea, where it gathereth feathers, and groweth to a foule, bigger then a Mallard, and lesser than a Goose, having blacke legs and bill or beake, and feathers blacke and white . . . . which the people of Lancashire call by no other name then a tree Goose."

Accompanying this description is the engraving of the bernicle-tree,

bearing its geese-progeny. From the open shells, in two cases, the little geese are seen protruding, while several of the fully-fledged fowls are disporting themselves in the sea below. Gerard's concluding piece of information, with its exordium, must not be omitted. "They spawne," says the wise apothecary, "as it were, in March or Aprill; the Geese are found in Maie or June, and come to fulnesse of feathers in the moneth after. And thus hauing, through God's assistance, discoursed somewhat at large of Grasses, Herbes, Shrubs, Trees, Mosses, and certaine excrescences of the earth, with other things moe incident to the Historie thereof, we conclude and end our present volume, with this woonder of England. For which God's name be euer honored and praised." It is to be remarked that Gerard's description of the goose-progeny of the barnacle-tree exactly corresponds with the appearance of the bird known to ornithologists as the "barnacle-goose," while there can be no doubt that, skilled as was this author in the natural-history lore of his day, there was no other feeling in his mind than that of firm belief in and pious wonder at the curious relations between the shells and their fowl-offspring. Gerard thus attributes the origin of the latter to the barnacles. He says nothing of the "wormeetin" holes and burrows so frequently mentioned by Boece, nor would he have agreed with the latter in crediting the "nature of the occeane see" with their production, save in so far as their barnacle-parents lived and existed in the waters of the ocean.

The last account of this curious fable which we may allude to in the present instance is that of Sir Robert Moray, who, in his work entitled "A Relation concerning Barnacles," published in the "Philosophical Transactions" of the Royal Society in 1677–'78, gives a succinct account of these crustaceans and their bird-progeny. Sir Robert is described as "lately one of His Majesties Council for the Kingdom of Scotland," and we may therefore justly assume his account to represent that of a cultured, observant person of his day and generation. The account begins by remarking that the "most ordinary trees" found in the western islands of Scotland "are Firr and Ash." "Being," continues Sir Robert, "in the Island of East, (Uist), I saw lying upon the shore a cut of a large Firr-tree of about 2½ foot diameter, and 9 or 10 foot long; which had lain so long out of the water that it was very dry: And most of the shells that had formerly cover'd it, were worn or rubb'd off. Only on the parts that lay next the ground, there still hung multitudes of little Shells; having within them little Birds, perfectly shap'd, supposed to be Barnacles." Here again the description applies to the barnacles; the "little birds" they are described as containing being of course the bodies of the shell-fish.

"The Shells," continues the narrator, "hang at the Tree by a Neck longer than the Shell," this "neck" being represented by the

stalk of the barnacle. The neck is described as being composed "of a kind of filmy substance, round, and hollow, and creassed, not unlike the Wind-pipe of a Chicken; spreading out broadest where it is fastened to the Tree, from which it seems to draw and convey the matter which serves for the growth and vegetation of the Shell and the little Bird within it." Sir Robert Moray therefore agrees, in respect of the manner of nourishment of the barnacles, with the opinion of Giraldus already quoted. The author goes on to describe the "Bird" found in every shell he opened; remarking that "there appeared nothing wanting as to the internal parts, for making up a perfect Seafowl: every little part appearing so distinctly, that the whole looked like a large Bird seen through a concave or diminishing Glass, colour and feature being everywhere so clear and neat." The "Bird" is most minutely described as to its bill, eyes, head, neck, breast, wings, tail, and feet, the feathers being "everywhere perfectly shaped, and blackish-coloured. All being dead and dry," says Sir Robert, "I did not look after the Internal parts of them," a statement decidedly inconsistent with his previous assertion as to the perfect condition of the "internal parts"; and he takes care to add, "Nor did I ever see any of the little Birds alive, nor met with anybody that did. Only some credible persons," he concludes, "have assured me they have seen some as big as their fist."

This last writer thus avers that he saw little birds within the shells he clearly enough describes as those of the barnacles. We must either credit Sir Robert with describing what he never saw, or with misconstruing what he did see. His description of the goose corresponds with that of the barnacle-goose, the reputed progeny of the shells; and it would, therefore, seem that this author, with the myth at hand, saw the barnacles only with the eyes of a credulous observer, and thus beheld, in the inside of each shell—if, indeed, his research actually extended thus far—the reproduction in miniature of a goose, with which, as a mature bird, he was well acquainted.

This historical ramble may fitly preface what we have to say regarding the probable origin of the myth. By what means could the barnacles become credited with the power of producing the well-known geese? Once started, the progress and growth of the myth are easily accounted for. The mere transmission of a fable from one generation or century to another is a simply explained circumstance, and one exemplified by the practices of our own times. The process of accretion and addition is also well illustrated in the perpetuation of fables; since the tale is certain to lose nothing in its historical journey, but, on the contrary, to receive additional elaboration with increasing age. Professor Max Müller, after discussing various theories of the origin of the barnacle-myth, declares in favor of the idea that confusion of language and alterations of names lie at the root of the error. The learned author of the "Science of Language" argues that the true barnacles

were named, properly enough, *bernaculæ*, and lays stress on the fact that bernicle geese were first caught in Ireland. That country becomes *Hibernia* in Latin, and the Irish geese were accordingly named *Hibernicæ*, or *Hiberniculæ*. By the omission of the first syllable—no uncommon operation for words to undergo—we obtain the name *Berniculæ* for the geese, this term being almost synonymous with the name *Bernaculæ* already applied, as we have seen, to the barnacles. Bernicle-geese and bernicle-shells, confused in name, thus became confused in nature; and, once started, the ordinary process of growth was sufficient to further intensify, and render more realistic, the story of the bernicle-tree and its wonderful progeny.

By way of a companion legend to that of the Barnacle-tree we may select the story of the "Lamb-tree" of Cathay, told by Sir John Maundeville, whose notes of travel regarding crocodiles' tears, and other points in the conformation of these reptiles, have already been referred to. Sir John, in that chapter of his work which treats "Of the Contries and Yles that ben bezonde the Lond of Cathay; and of the Frutes there," etc., relates that in Cathay "there growethe a manner of Fruyt, as thoughe it were Gowrdes: and whan thei ben rype, men kutten (cut) hem a to (them in two), and men fynden with inne a lytylle Best (beast), in Flessche in Bon and Blode (bone and blood) as though it were a lytylle Lomb (lamb) with outen wolle (without wool). And men eten both the Frut and the Best; and that," says Sir John, "is a gret marveylle. Of that fruit," he continues, "I have eten; alle thoughe it were wondirfulle"—this being added, no doubt, from an idea that there might possibly be some stay-at-home persons who would take Sir John's statement *cum grano salis*. "But that," adds this worthy "knyght of Ingelond," "I knowe wel that God is marveyllous in his Werkes." And not to be behind the inhabitants of Cathay in a tale of wonders, the knight related to these Easterns "als gret a marveylle to hem that is amonges us; and that was of the Bernakes. For I tolde hem hat in oure Countree weren Trees that beren a Fruyt, that becomen Briddes (birds) fleeynge: and tho that fellen in the Water lyven (live); and thei that fallen on the Erthe dyen anon: and thei ben right gode to mannes mete (man's meat). And here had thei als great marvayle," concludes Sir John, "that sume of hem trowed it were an impossible thing to be." Probably the inhabitants of Cathay, knowing their own weakness as regards the lamb-tree, might possess a fellow feeling for their visitor's credulity, knowing well, from experience, the readiness with which a "gret marvayle" could be evolved and sustained.

Passing from the sphere of the mythical and marvelous as represented in mediæval times, we may shortly discuss a question which, of all others, may justly claim a place in the records of zoölogical curiosities—namely, the famous and oft-repeated story of the "Toad from the solid rock," as the country newspapers style the incident.

Regularly, year by year, and in company with the reports of the sea-serpent's reappearance, we may read of the discoveries of toads and frogs in situations and under circumstances suggestive of a singular vitality on the part of the amphibians, of more than usual credulity on the part of the hearers, or of a large share of inventive genius in the narrators of such tales. The question possesses for every one a certain degree of interest, evoked by the curious and strange features presented on the face of the tales. And it may therefore not only prove an interesting but also a useful study, if we endeavor to arrive at some just and logical conceptions of these wonderful narrations.

Instances of the discovery of toads and frogs in solid rocks need not be specially given; suffice it to say that these narratives are repeated year by year with little variation. A large block of stone or face of rock is detached from its site, and a toad or frog is seen hereafter to be hopping about in its usual lively manner. The conclusion to which the bystanders invariably come is, that the animal must have been contained within the rock, and that it was liberated by the dislodgment of the mass. Now, in many instances, cases of the appearance of toads during quarrying-operations have been found, on close examination, to present no evidence whatever that the appearance of the animals was due to the dislodgment of the stones. A frog or toad may be found hopping about among some recently formed *débris*, and the animal is at once seized upon and reported as having emerged from the rocks into the light of day. There is in such a case not the slightest ground for supposing any such thing; the animal may more reasonably be presumed to have hopped into the *débris* from its ordinary habitat. But, laying aside narratives of this kind, which lose their plausibility under a very commonplace scrutiny, there still exist cases, reported in an apparently exact and truthful manner, in which these animals have been alleged to appear from the inner crevices of rocks after the removal of large masses of the formations. We shall assume these latter tales to contain a plain, unvarnished statement of what was observed, and deal with the evidence they present on this footing.

One or two notable examples of such verified tales are related by Smellie, in his "Philosophy of Natural History." Thus, in the "Memoirs of the French Academy of Science" for 1719, a toad is described as having been found in the heart of an elm-tree; and another is stated to have been found in the heart of an old oak-tree, in 1731, near Nantz. The condition of the trees is not expressly stated, nor are we afforded any information regarding the appearance of the toads—particulars of considerable importance in view of the suggestions and explanations to be presently brought forward. Smellie himself, while inclined to be skeptical in regard to the truth or exactness of many of the tales told of the vitality of toads, yet regards the matter as affording food for reflection, since he remarks: "But I mean not to persuade, for I

can not satisfy myself; all I intend is, to recommend to those gentlemen who may hereafter chance to see such rare phenomena, a strict examination of every circumstance that can throw light upon a subject so dark and mysterious; for the vulgar, ever inclined to render uncommon appearances still more marvelous, are not to be trusted."

This author strikes the key-note of the inquiry in his concluding words, and we shall find that the explanation of the matter really lies in the clear understanding of what are the probabilities, and what the actual details, of the cases presented for consideration. We may firstly, then, glance at a few of the peculiarities of the frogs and toads, regarded from a zoölogical point of view. As every one knows, these animals emerge from the egg in the form of little fish-like "tadpoles," provided with outside gills, which are soon replaced by inside gills, resembling those of fishes. The hind-legs are next developed, and the fore-limbs follow a little later; while, with the development of lungs, and the disappearance of the gills and tail, the animal leaves the water, and remains for the rest of its life an air-breathing, terrestrial animal. Then, secondly, in the adult frog or toad, the naturalist would point to the importance of the skin as not only supplementing but, in some cases, actually supplanting the work of the lungs as the breathing organ. Frogs and toads will live for months under water, and will survive the excision of the lungs for like periods; the skin in such cases serving as the breathing surface. A third point worthy of remembrance is included in the facts just related, and is implied in the information that these animals can exist for long periods without food, and with but a limited supply of air. We can understand this toleration on the part of these animals when we take into consideration their cold-blooded habits, which do not necessitate, and which are not accompanied by, the amount of vital activity which we are accustomed to note in higher animals. And, as a last feature in the purely scientific history of the frogs and toads, it may be remarked that these animals are known to live for long periods. One pet toad is mentioned by a Mr. Arscott as having attained, to his knowledge, the age of thirty-six years; and a greater age still might have been recorded of this specimen, but for the untoward treatment it sustained at the hands, or rather beak, of a tame raven. In all probability it may be safely assumed that, when the conditions of life are favorable, these creatures may attain a highly venerable age—regarding the lapse of time from a purely human and interested point of view.

We may now inquire whether or not the foregoing considerations may serve to throw any light upon the tales of the quarryman. The first point to which attention may be directed is that involved in the statement that the amphibian has been imprisoned in a *solid* rock. Much stress is usually laid on the fact that the rock was solid; this fact being held as implying the great age, not to say antiquity, of the rock and its supposed tenant. The impartial observer, after an exami-

nation of the evidence presented, will be inclined to doubt greatly the justification for inserting the adjective "solid"; for usually no evidence whatever is forthcoming as to the state of the rock prior to its removal. No previous examination of the rock is or can be made, from the circumstance that no interest can possibly attach to its condition until its removal reveals the apparent wonder it contained, in the shape of the live toad. And we rarely, if ever, find mention of any examination of the rock being made subsequently to the discovery. Hence, a first and grave objection may be taken to the validity of the supposition that the rock was solid, and it may be fairly urged that on this supposition the whole question turns and depends. For, if the rock can not be proved to have been impermeable to and barred against the entrance of living creatures, the objector may proceed to show the possibility of the toad having gained admission, under certain notable circumstances, to its prison-house.

The frog or toad in its young state, and having just entered upon its terrestrial life, is a small creature, which could, with the utmost ease, wriggle into crevices and crannies of a size which would almost preclude such apertures being noticed at all. Gaining access to a roomier crevice or nook within, and finding there a due supply of air, along with a dietary consisting chiefly of insects, the animal would grow with tolerable rapidity, and would increase to such an extent that egress through its aperture of entrance would become an impossibility. Next, let us suppose that the toleration of the toad's system to starvation and a limited supply of air is taken into account, together with the fact that these creatures will hibernate during each winter, and thus economize, as it were, their vital activity and strength; and after the animal has thus existed for a year or two—no doubt under singularly hard conditions—let us imagine that the rock is split up by the wedge and lever of the excavator; we can then readily enough account for the apparently inexplicable story of "the toad in the rock." "There is the toad and here is the solid rock," say the gossips. "There is an animal which has singular powers of sustaining life under untoward conditions, and which, in its young state, could have gained admittance to the rock through a mere crevice," says the naturalist in reply. Doubtless, the great army of the unconvinced may still believe in the tale as told them, for the weighing of evidence and the placing *pros* and *cons* in fair contrast are not tasks of congenial or wonted kind in the ordinary run of life. Some people there will be who will believe in the original solid rock and its toad, despite the assertion of the geologist that the earliest fossils of toads appear in almost the last-formed rocks, and that a live toad in rocks of very ancient age—presuming, according to the popular belief, that the animal was inclosed when the rock was formed—would be as great an anomaly and wonder as the mention as an historical fact of an express-train or the telegraph in the days of the patriarchs. The reasonable

mind, however, will ponder and consider each feature of the case, and will rather prefer to countenance a supposition based on ordinary experience than an explanation brought ready-made from the domain of the miraculous. While not the least noteworthy feature of these cases is that included in the remark of Smellie respecting the tendency of uneducated and superstitious persons to magnify what is uncommon, and in his sage conclusion that, as a rule, such persons in the matter of their relations "are not to be trusted."

But it must also be noted that we possess valuable evidence of a positive and direct kind bearing on the duration of life in toads under adverse circumstances; and, as this evidence tells most powerfully against the supposition that the existence of those creatures can be indefinitely prolonged, it forms of itself a veritable court of appeal in the cases under discussion. The late Dr. Buckland, curious to learn the exact extent of the vitality of the toad, caused, in the year 1825, two large blocks of stone to be prepared. One of the blocks was taken from the oölite limestone, and in this first stone twelve cells were excavated. Each cell was one foot deep and five inches in diameter. The mouth of each cell was grooved so as to admit of two covers being placed over the aperture; the first or lower cover being of glass, and the upper one of slate. Both covers were so adapted that they could be firmly luted down with clay or putty; the object of this double protection being that the slate cover could be raised so as to inspect the contained object through the closed glass cover without admitting air. In the second or sandstone block a series of twelve cells was also excavated; these latter cells being, however, of smaller size than those of the limestone block, each cell being only six inches in depth by five inches in diameter. These cells were likewise fitted with double covers.

On November 26, 1825, a live toad—kept for some time previously to insure its being healthy—was placed in each of the twenty-four cells. The largest specimen weiged 1,185 grains, and the smallest 115 grains. The stones and the immured toads were buried on the day mentioned, three feet deep, in Dr. Buckland's garden. There they lay until December 10, 1826, when they were disinterred and their tenants examined. All the toads in the smaller cells of the sandstone block were dead, and from the progress of decomposition it was inferred that they had succumbed long before the date of disinterment. The majority of the toads in the limestone block were alive, and, curiously enough, one or two had actualy increased in weight. Thus, No. 5, which at the commencement of its captivity had weiged 1,185 grains, had increased to 1,265 grains; but the glass cover of No. 5's cell was found to be cracked. Insects and air must, therefore, have obtained admittance and have afforded nourishment to the imprisoned toad; this supposition being rendered the more likely by the discovery that in one of the cells, the covers of which were also cracked and the ten-

ant of which was dead, numerous insects were found. No. 9, weighing originally 988 grains, had increased during its incarceration to 1,116 grains; but No. 1, which in the year 1825 had weighed 924 grains, was found in December, 1826, to have decreased to 698 grains; and No. 11, originally weighing 936 grains, had likewise disagreed with the imprisonment, weighing only 652 grains when examined in 1826.

At the period when the blocks of stone were thus prepared, four toads were pinned up in holes five inches deep and three inches in diameter, cut in the stem of an apple-tree; the holes being firmly plugged with tightly fitting wooden plugs. These four toads were found to be dead when examined along with the others in 1826; and of four others inclosed in basins made of plaster-of-Paris, and which were also buried in Dr. Buckland's garden, two were found to be dead at the end of the year, their comrades being alive, but looking starved and meager. The toads which were found alive in the limestone block in December, 1826, were again immured and buried, but were found to be dead, without leaving a single survivor, at the end of the second year of their imprisonment.

These experiments may fairly be said to prove two points. They firstly show that even under circumstances of a favorable kind when compared with the condition popularly believed in—namely, that of being inclosed in a *solid* rock—the limit of the toad's life may be assumed to be within two years; this period being no doubt capable of being extended when the animal possesses a slight advantage, exemplified by the admission of air and insect-food. And, secondly, we may argue that these experiments show that toads when rigorously treated, like other animals, become starved and meager, and by no means resemble the lively, well-fed animals reported as having emerged from an imprisonment extending, in popular estimation, through periods of inconceivable duration. These tales are, in short, as devoid of actual foundation as are the modern beliefs in the venomous properties of the toad, or the ancient beliefs in the occult and mystic powers of various parts of its frame when used in incantations. Shakespeare, while attributing to the toad venomous qualities, has yet immortalized it in his famous simile, by crediting it with the possession of a "precious jewel." But even in the latter case the animal gets but scant justice; for science strips it of its poetical reputation, and in this, as in other respects, shows it, despite fable and myth, to be an interesting but commonplace member of the animal series.—*Gentleman's Magazine.*

THE ELECTRICAL POLYSCOPE.

THE electrical polyscope is a simple and ingenious apparatus for giving light in the cavities of the human body, the invention of M. Trouvé, who has distinguished himself by the contrivance of several other instruments useful to physicians and involving curious applications of electricity. It consists of an energetic and constant battery, of a reservoir or secondary battery, and of parabolic reflectors adapted to the different uses to which it may be applied, which are furnished with additional mirrors or used without them. A minute platinum thread, connected with the conducting wires of the battery, is placed in the middle of each reflector. When the battery is put in action, the wire becomes incandescent. A special rheostat is provided to regulate the flow of the electricity, which plays a part similar to that of the faucet of a water-reservoir, and controls the flow of the fluid with such exactness as to permit the finest threads of platinum

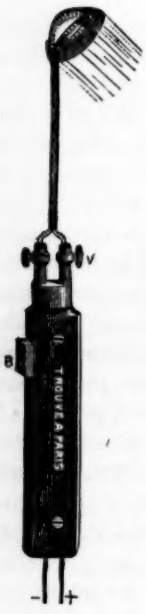


FIG. 1.

FIG. 2.

FIG. 3.

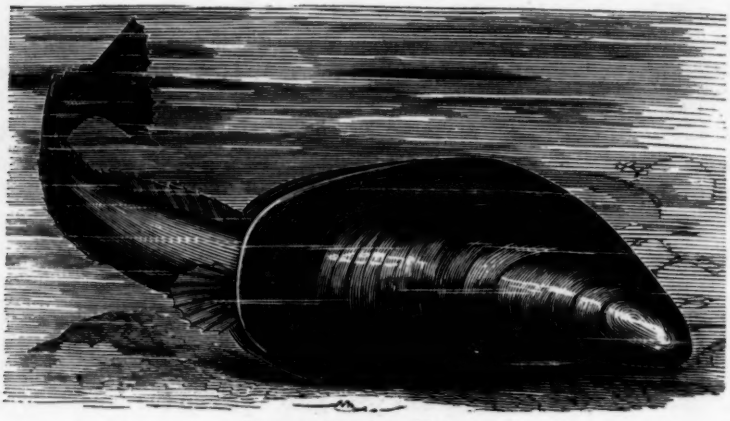
to approach the point of fusion without passing it. The melting-point of the wires used having been determined in the beginning, can always afterward be avoided without trouble. A galvanometer with two circuits, in which the electro-motive force of the reservoir and that of the battery are in opposition, enables the operator to observe

the condition of the apparatus at every moment. Figs. 1 and 3 represent two of the reflectors. That shown in Fig. 1 is used to light up the mouth, and is of such power as to render the teeth transparent, and make them show every detail of their condition. Placed on the extremity of a probe inserted in the œsophagus, it makes it possible to observe the condition of the stomach. Fig. 3 shows the reflector with mirrors for use in laryngoscopy and rhinoscopy. This adaptation of the instrument may be used by dentists to show the back part of the teeth, without compelling the patient to assume a disagreeable position, as in Fig. 2. The polyscopes are superior to every other device for introducing light to all parts of the human body. With them the source of light may be placed at as minute a distance as is desired from the part to be examined without inconvenience to the operator. With a slight modification the polyscope may be employed as the instrument for performing the very different operation of cauterization. It is of service in other fields than those of medicine and surgery. Captain Manceron, at St. Thomas of Aquinas, has used it to examine the interior of shells and cannon. It is employed likewise in powder magazines, and is a similar apparatus to that used by divers and gatherers of oysters, corals, and pearls, to light up the bottom of the sea.

CAPTURE AMONG THE MOLLUSKS.

MR. STEPHEN CLOGG has kindly forwarded us a box containing a shanny and a mussel, which he describes as having been taken in the harbor at Looe, Cornwall, in exactly the position represented in the accompanying illustration. The shanny and mussel, our correspondent writes, were taken by a fisherman who was gathering mussels for bait at Looe. Mussels are found in great numbers at the bottom of the harbor there, and the fishermen use a long-handled, four-pronged fork for catching them. A boat is moored over the spot on which the mussels are to be found, and the fork is employed to bring them from below into the boat. In the case in question, our correspondent assures us the shanny and mussel were brought up as shown in our illustration. The fish was alive when taken, and its head firmly fixed in the mussel. This certainly may be considered a curious capture, and from the evidence it may be fairly assumed that the shanny, seeing a tempting mussel with its mouth open, was induced to pop his head in—an operation which Master Mussel doubtless resented by immediately closing its valves, retaining the fish in its deadly grasp. A case in point of fish being taken in this way is mentioned by Couch, in which Lacépède records an instance where, as he (Lacépède) supposes, a shanny had made an attempt to feed on an oyster

that lay with its valves open, in consequence of which it became shut up a prisoner by the closing of the shell. In this case, however, the shanny was more fortunate than the one taken the other day, for it is stated that in this condition of confinement the fish had continued so long that the oyster had been dredged and carried to a considerable



SHANNY CAUGHT BY MUSSEL.

distance. Upon opening it, the captive was again set free alive, and without injury. Shanny are very retentive of life, and would be found nice additions to salt-water aquaria.

In our columns some years ago was recorded an even more extraordinary capture than either of the above, by Mr. Frank Buckland. As doubtless many of our readers have not seen it, we reproduce Mr. Buckland's remarks and the illustration which appeared at the time:

"Some time since, when examining the famous oyster-beds at Helston, near Falmouth, Mr. Fred Hill, of Helston, was kind enough to accompany me and my friend Mr. Howard Fox, of Falmouth, in our expedition. Mr. Hill mentioned to me at the time that he had a curious specimen of a bird that had been caught by an oyster. The bird and oyster had been mounted in a case by Mr. Vingor, of Penzance. I have received from Mr. Hill a photograph of the above event, which I have since had engraved as above. The history is, that a woman who sells oysters went one morning to the Helford River and found the bird —a common rail—dead, with its beak held quite firmly by the oyster, which was still alive.

"The bird in all probability was wandering along the foreshore looking for his dinner, and Mr. Oyster—possibly left longer by the tide than usual—was opening his shells waiting the incoming water. The hungry rail, seeing something that looked like a white and dainty bit of food, pecked at the body of the oyster, and probably pricked him sharply with his beak. The oyster then snapped his shells together as

quick as a rat-trap, and the poor bird instantly became a prisoner to die (or possibly get drowned as the tide rose) in his prison.

"A story is told of a nigger in America who was caught in a somewhat similar manner. The nigger put his tongue between the shells

RAIL CAUGHT BY OYSTER.

of a half-opened oyster to suck out the juice, and the oyster caught him tightly by the tongue. Sambo, when released, was chaffed about it. 'Why, the oyster could not have hurt you,' said his friend; 'he has no teeth.' 'No,' said Sambo, 'he 'ave no teeth, but by Gorry he have dam hard gums!'"

In the late report on "The Sea-Fisheries" Mr. Buckland published a large mass of information in regard to mussels. In the course of this he says:

"Mussels have a great number of enemies, the chief of which are

five-fingers, or star-fish, and whelk-tingles. It is most interesting to watch the five-fingers eating the mussels. The whelk-tingles, or white buckies, as they are called at Montrose, will clear off in a few hours a large acreage of mussels. The proprietors, therefore, employ women and children to pick them off at low tide. Not only are mussels largely used as bait, but they are a favorite food of the poor, and are sold in large quantities in the streets of the large towns of England—Manchester, Liverpool, Birmingham, etc. They are, in fact, 'the poor man's oyster.' So much, indeed, are mussels used as food, that a proposition was more than once seriously made to us by the fishermen that it should be illegal to use mussels for human food. As regards their value as food, I have made the following calculation: There are on the average thirty-nine mussels to the pound, equal to 87,360 mussels in a ton. These cost first hand £1 5*s.* per ton; the cost to the retailers is £3 6*s.* 8*d.* per ton. In March, 1876, a large number of crows were observed eating mussels (query, fresh-water) in the Norfolk Broads. There are large quantities of mussels in many of the broads and rivers, especially in South Walsham Broad, and also, I believe, in Hoveton Broad, Ormesby Broad, and Fritton Water. At the present time I believe no use whatever is made of them; it is as well to see if these mussels can not be cultivated and used for bait."—*Land and Water.*

HOW INSECTS DIRECT THEIR FLIGHT.*

By M. J. DE BELLESME.

THE works of M. Marey have nicely determined the difference between the manner in which birds and insects fly. The bird can change at will the angle of vibration of his wings, and therefore these organs serve to steer his flight. The insect is deprived of this power, because the angle of vibration, as a rule, is invariable in each species, the flying-muscles not being in the wings, but in that part of the thorax which supports the wings.

Knowing these facts, I concluded that if the wing of the insect be merely a motor apparatus, the steering function must be sought for elsewhere; and, from numerous experiments made upon insects of every order, I am convinced that the steering power depends upon the position of the head and thorax, this, in its turn, depending upon the respective positions of the center of gravity and the axis of suspension (*l'axe de sustention*). Both these elements are sometimes movable, but more often it is the center of gravity which changes.

* From a paper read before the Paris Academy of Sciences, and published in "Comptes Rendus." Translated by M. Howland.

There are a few insects in which the motor and steering functions are united, the flying-muscles being attached to the wings. These insects fly gracefully, like birds; still, the abdomen is very long, flexible, and greatly augments the ease and variety of motion; this is specially apparent in the *Agrions*—the dragon-fly, for example. It is probable that the *Lepidoptera* (butterflies, moths) should be ranged in the same category, for the movement of their wings is something like that of birds; the anatomy of their thoracic muscles, however, has not yet been completely analyzed.

In the *Hymenoptera* (bees, wasps, etc.) are found the first indications of separate functions of translation and direction. The wings, having acquired a very perfect automatism by which the axis of suspension has become permanently fixed, are solely devoted to the function of movement. The abdomen has become pediculated and exceedingly mobile. As it bends up or straightens out, the center of gravity is carried forward or backward. The *Cynips* (gall-flies, etc.) and *Ichneumonides* (insects that prey upon the eggs of other insects) offer extreme examples. If the abdomen be prevented from moving, the animal can still fly, but can not direct its course. Moreover, the posterior legs of these insects are long, as in the *Polistes* and *Megachiles*, and this also aids in displacing the center of gravity.

In the *Orthoptera* (crickets, grasshoppers, etc.) the abdomen is but slightly movable, and the steering power is almost wholly in the hind-feet; but, as these are already differentiated for an equally important function, that of jumping, they lend themselves with a bad grace to the former function, and so the hopping insects fly very badly.

Thus far we have seen the two pairs of wings devoted to the motor function. We come now to a class of insects in which the functional adaptation is not secured through organs performing other functions and lending themselves to extra duties, but where the adaptation is secured through its own proper organs—one of the pairs of wings, indeed, which, diverted from the motor function, has become a steering apparatus.

In the group of *Coleopters* (beetles), only one pair of wings, the posterior, serve to sustain the insect; the surface of support, therefore, is considerably diminished, and the flight is heavy or clumsy. But this disadvantage is compensated by the greater extent of surface afforded by the non-modified pair. This surface, indeed, is so great that the insect is obliged to fold it up during rest. The abdomen of the *Coleoptera* is stiffly fixed to the thorax, and consequently is but slightly movable; but this quality is unnecessary, since a special organ, the elytrum (wing-case), has power to displace the center of gravity. Raised up over the thorax during flight, the elytrum forms a little swaying mass above the center of gravity, and the slightest motion of this mass affects the balance of the insect. Remove the wing-cases, and the insect still flies, but has no power to direct its motion, which

is upward, downward, or horizontal, according to the position of the center of gravity at the moment of the experiment. M. Plateau has clearly demonstrated that the normal position of this point varies with each species.

One very small group, the *Cetoniadæ*, fly with the wing-cases down—an interesting fact, for in this instance they act upon the axis of suspension, and effect a step toward the state of complete differentiation which we find in the following group.

In the *Diptera* (mosquitoes, flies, etc.) the steering faculty reaches its highest development. The second pair of wings is transformed into organs having the special function of steering, the balancers or poisers; and these insects have accordingly a remarkable perfection of movement. A single pair of wings does all the flying, and, as they are not large, the diminution of the supporting surface is compensated by greater rapidity of vibration. I have proved by experiment that the balancers act by displacing the axis of suspension. Suppress the balancers, and the flight becomes fatally downward, because the normal and invariable position of the center of gravity is in front of the axis of suspension; the animal, therefore, can not modify his movement in any way, the abdomen being but slightly movable, and the balancers cut off. If, now, we come to his relief and attach a tiny weight to his abdomen, just sufficient to carry the center of gravity back to its normal place, we restore to the insect the power to perform all his aërial evolutions.

SKETCH OF JAMES CLERK MAXWELL.

AMONG the present generation of English physicists none have attained to greater eminence, or have made more valuable additions to this department of science, than the late Professor Maxwell. The splendid promise that his accomplished work gave of future work makes his death, at the early age of forty-nine, at the height of his powers, an irreparable loss to science. An accomplished mathematician, an unexcelled experimenter, he was peculiarly fitted to carry on those delicate researches in the domain of molecular physics by which he made it his own, and in which he was without a rival. Possessed of a vivid imagination, he had that power of holding it well under control, and making it subservient to the conditions of scientific investigation, that belongs only to the highest types of mind, and which is essential to the best and most valuable work in science. Though possessed of the power of direct and lucid exposition, he was never what is termed a popular lecturer. The subjects he considered, and his con-

densed form of presenting them, debarred any, save those whose knowledge was sufficiently extended, from following him in his exposition. But, by the students who enjoyed the privilege of attending his lectures, he was regarded as a teacher of the greatest value, though at times somewhat difficult to follow. Of a kindly and genial disposition, Professor Maxwell secured the affectionate regard of those with whom he came in contact, and to many his death comes as the double loss of a companion in work and of a valued friend.

Professor Maxwell was born in the year 1831, being the only son of John Clerk Maxwell, Esq., of Middlebie, Dumfriesshire, Scotland. When eight years old his mother died, and his father thereafter lived a retired life on his estate, devoting himself to the education of his son and the care of his property. He received his early education at the Edinburgh Academy, and after leaving there entered the University of Edinburgh. In 1850 he went to Cambridge, from which he was graduated in 1854, as second wrangler. In the following year he became a Fellow of Trinity College, and a year later accepted the position of Professor of Natural Philosophy in Marischal College, Aberdeen, which he held until the fusion of this and King's College. He succeeded Professor Goodeve as Professor of Natural Philosophy and Astronomy in King's College in 1860, and remained there until the death of his father in 1865, when he retired to his estate in Scotland. None of these positions had been entirely in accordance with his tastes, or such as to give full scope to his abilities. Such an opportunity as in every way suited him was opened to him in 1871, by the invitation of the University of Cambridge to the newly created chair of Experimental Physics, which he held until the time of his death. Shortly after his acceptance of the position, the Cavendish Laboratory, with a complete equipment of apparatus, was presented to the university by the Duke of Devonshire, and it is due to the superintendence of Professor Maxwell that this laboratory is so excellently adapted to its purpose.

During the winter of 1878 and 1879 Professor Maxwell's health failed him, and in the spring he betook himself to Scotland in the hope of regaining it. He was not improved by his trip, and he therefore returned to Cambridge, where under the treatment of Dr. Paget he grew better, and hopes were entertained of his recovery. The improvement, however, was not lasting, and he rapidly grew weaker until his death, on the 5th of November last.

Professor Maxwell commenced original work at an early age, and his contributions to the "Transactions" of societies and scientific periodicals have been voluminous. A mathematical paper "On the Description of Oval Curves, and those having a Plurality of Foci," was submitted by him to the Royal Society of Edinburgh, through Professor Forbes, before he was fifteen. While at the University of Edinburgh he contributed two elaborate papers to the Edinburgh Royal Society,

one on the "Theory of Rolling Curves," and the other on the "Equilibrium of Elastic Solids."

During his college course in Cambridge he developed the germs of his future important work on electricity and magnetism, in a paper on "Faraday's Lines of Force," and five other papers on the same subject were contributed by him to the "Philosophical Magazine" during 1861 and 1862. Only a few months after obtaining his Cambridge degree in 1854, he contributed to the Cambridge Philosophical Society a remarkable paper on the "Transformation of Surfaces by Bending." In 1857 his paper on the "Motions of Saturn's Rings" obtained for him the Adams prize in the University of Cambridge. He received in 1860 the Rumford medal from the Royal Society for his "Researches on the Composition of Colors" and other optical papers. The subject of color Professor Maxwell has treated with great success, both experimentally and theoretically, his papers on the subject extending from 1855 to 1872. His important paper on a "Dynamical Theory of the Electro-magnetic Field," in which he endeavored to explain electric and magnetic forces by means of stresses and motions of the medium, and thus do away with the notion of action at a distance, was read before the Royal Society in 1864, and printed in the "Transactions" of that year. His contributions to the Kinetic theory of gases form one of the most important and valuable of his investigations. His first paper on this subject appeared in the "Philosophical Magazine" of 1860, and he at different times since published various others. Before him, Clausius had made a great advance by his explanation by this theory of the relation between the volume, temperature, and pressure of a gas, the cooling of it by expansion, and the slowness of diffusion and conduction of heat in it. An investigation was also made by him of the relation between the length of the mean free path of a particle, the number of particles in a given space, and their least distance when in collision. Maxwell by an investigation of the collisions of a number of perfectly elastic spheres, first when they are all of the same mass, and then when they are of different masses, reached the law of Gay-Lussac, that in a unit of volume there is the same number of particles in all gases when at the same temperature and pressure. He also explained gaseous friction, and showed that the coefficient of viscosity is independent of the density of the gas. The approximate length of the mean free path was first deduced by him from data furnished by Stokes.

Pursuing the same subject, he made a few years later a valuable series of experimental investigations on the viscosity and internal friction of air and other gases, the results of which were brought to the attention of the Royal Society in 1866. A paper on "A Method of making a Direct Comparison of Electrostatic with Electro-magnetic Force, with a Note on the Electro-magnetic Theory of Light," was also presented to that body in 1868. He took great interest in graphical

statics, and contributed in 1869 a paper on the subject, under the title "On Reciprocal Figures, Forms, and Diagrams of Forces," to the Royal Society of Edinburgh. Besides his numerous articles giving the results of investigations, a few only of which are above mentioned, he contributed to the "Encyclopædia Britannica" the articles "Atom," "Attraction," "Capillary Action," "Constitution of Bodies," "Diagrams," "Diffusion," "Ether," "Faraday," and "Harmonic Analysis." Of the works published by Professor Maxwell, that on "Electricity and Magnetism" is his most important, giving the results of his laborious life in this department of physics. Besides this, a work on "The Theory of Heat," and a small text-book on "Matter and Motion" have been published by him. To these must be added his recently published volume on the "Electrical Researches of the Hon. Henry Cavendish," which he has enriched with copious and valuable notes.

Of his more important pieces of experimental work, that connected with the determination of the British Association Unit of Electric Resistance and his verification of Ohm's law made by him at the Cavendish Laboratory, should be here mentioned.

Professor Maxwell was Fellow of the Royal Societies of Edinburgh and London, and of the Cambridge Philosophical Society, and a voluminous contributor to their "Transactions." In 1872 he was elected Honorary Fellow of Trinity College, Cambridge, and in the same year was created honorary LL. D. of Edinburgh, while in 1876 he received the honorary degree of D. C. L. at Oxford. He was appointed honorary member of the American Academy of Arts and Sciences, of Boston, in 1874; member of the American Philosophical Society of Philadelphia, 1875; and honorary member of the New York Academy of Sciences in 1876. He was also correspondent in the mathematical class to the Imperial Academy of Sciences, Göttingen; corresponding member of the Imperial Academy of Sciences, Vienna; and associate of the Amsterdam Royal Academy of Sciences.

Professor Maxwell did not confine himself to scientific research and exposition, but occasionally appeared in the field of literature with poetic effusions of a satirical character on scientific subjects.

Professor Tait, in his review in "Nature" of Professor Maxwell's work, hopes "that these scattered gems may be collected and published, for they are of the very highest interest, as the work during leisure hours of one of the most piercing intellects of modern times. Every one of them contains evidence of close and accurate thought, and many are in the happiest form of epigram." Two samples of this poetic work are given by Professor Tait, one of which we append:

"To follow my thoughts as they go on,
Electrodes I'd place in my brain;
Nay, I'd swallow a live entozoön,
New feelings of life to obtain."

CORRESPONDENCE.

AMHERST COLLEGE AND EVOLUTION.

Messrs. Editors.

AFTER the publication of President Seelye's peculiar statement with respect to the teaching at Amherst College regarding the law of evolution, feeling a graduate's interest in the matter, I made careful inquiry, and find that, at a meeting of the faculty held a few years ago, the present Professor of Geology was requested by President Stearns to deliver a course of lectures on evolution, and the faculty, without any audible dissent, seconded the request. At the time, this Professor was known to believe in the evolution law. Since then, evolution has been taught in the department of zoölogy, the Professor or instructor giving such an exposition of the facts favoring and seeming to militate against the doctrine as would be suitable to students. By vote of the faculty, also, Dana's and Le Conte's text-books are used, both of which accept evolution, the second very positively. There is now established an instructorship in biology. Moreover, I learn that every professor in the scientific departments of study believes in the doctrine in question. The following language, with which one of the professors is credited, shows quite a different state of feeling in the institution from what President Seelye would lead us to believe: "Taking all the relations, as I judge them from my standpoint, it must be concluded that the truth lies somewhere within the lines of the evolution theories. Such unquestionably is the teaching of real science in nearly all places where it has both freedom and intelligence. As to its materialistic or atheistic tendencies, I regard it as having none whatever, except in the hollow brains of those would-be sages who talk most concerning that of which they know the least. The most important point is to find out the truth in nature, and teach that, regardless of all bearing it may have on any of our preconceived notions."

Upon this state of facts, certainly very different from that which the ordinary reader would infer from President Seelye's statement (it is not entirely clear what he means), it may be concluded that Amherst College is working along abreast of the best thought of the time, notwithstanding the unfavorable reflection cast upon it by its President's remarks. There was a period when Amherst College had a reputation for its achievements in the field of science. Latterly, it has ceased to have much in that direction, chiefly because dominated by the influence of the teaching in its senior class-room, under the name of mental and moral science, of a collection of *bizarre* doctrines, expressed in words which have no corresponding thoughts, wholly unscientific and without any philosophical substance or consistency. Since President Seelye thinks he believes in these doctrines, it is hardly to be expected that he could apprehend the truth of statements which express laws of nature scientifically ascertained and verified. The only way in which he could be made to see such truth would be for him to follow the course found necessary by some of his graduates, namely, to unlearn everything taught at Amherst as philosophy, before attempting to take a step forward in the path of true philosophical knowledge.

Of course, to the world of scholars at large, President Seelye's strictures, if they were meant to have application broadly to the doctrine of evolution, will not have the slightest interest; but it ought not to be pleasant for those who have any especial regard for the college to see its president putting forth, in an apparently ill-tempered fling, a statement characterizing unfairly a doctrine which a large portion of the scientific and philosophical world accepts as a natural law abundantly verified, and creating an impression, with respect to the college teaching, which does not seem to be true, and which, if it were true, would only bring discredit upon the institution.

DANIEL G. THOMPSON.

NEW YORK CITY, *February* 10, 1880.

A CONSIDERATION OF SUICIDE.

Messrs. Editors.

THE article under this heading, in your April number, is an ingenious discussion of the subject, and one which also, considering the solemn matter of which it treats, we must suppose to be *ingenuous*, although through the entire argument runs the flaw of an erroneous definition. "What is suicide?" asks the writer, and answers, "The voluntary termination of one's own life." Perhaps we should be content with calling this definition imperfect. It has certainly led the writer into error, and to a distinction between egoistic and altruistic suicide, which has no foundation either in ethics or in the definitions of criminal law. There

is no such thing as altruistic suicide. Suicide is characterized by the *intention* to take one's own life. A voluntary death characterized by the intention to save life is certainly not suicide. To constitute suicide there must be criminal motive, just as in the case of any other crime. It must be *felo de se;* in its simplest statement, self-murder. This, in fact, is the definition of Blackstone: "The act of designedly destroying one's own life committed by a person of years of discretion and of sound mind; self-murder." It must be distinguished, that is, from simple voluntary death, as murder is distinguished from simple homicide. There must be the intent to destroy life from a selfish or malign motive. The unjustifiable motive in the case of the suicide is the selfish desire to terminate life, and thus avoid some present or threatened evil, without regard to the evil or unhappiness inflicted on survivors. In the strongest case that can be put, that of an aged man who feels that he is a burden on his friends (or those who should be such), a pure and unselfish motive would incline him rather to inflict that burden on them than the far heavier burden and disgrace of a (to him) criminal and (to them) criminating death.

For the rest—and to embrace under one head all Mr. Hopkins's illustrations of altruistic suicides, viz., heroes, martyrs, and engineers—the man who dies *defending or maintaining a trust* is in no sense a suicide. His death is made to him, by *moral reasons*, inevitable.

W. W. Lord.

Cooperstown, New York, *March* 10, 1880.

"ORIGIN OF CRIMINAL LAW."

Messrs. Editors.

Charles J. Buell calls attention in your April number to some statements in Mr. W. W. Billson's article, "The Origin of Criminal Law," illustrating the way in which early law-makers seem to have taken the revengeful feelings of the aggrieved parties into consideration in imposing punishments upon wrong-doers.

He says: "There appears to be something of this sort in the custom that will hold a man blameless if he shoot and kill the midnight robber who is merely *trying* to *effect* an entrance into his house, but will not hold him guiltless if he take the same sort of vengeance on the robber after he has once *entered* the house and *stolen* the goods and *escaped* with them."

This law is based upon a principle as far as possible from the idea of gratifying the injured party's sense of revenge.

When a man awakes in the night-time and finds another man trying to get into his house, he is not obliged to ask him if he intends to steal or *murder*. The man within may be timid; he may apprehend great personal danger; he may have the impression that an attempt is being made to murder him. The law protects him in acting upon such apprehension. This is simply self-defense. There is no question of anger or revenge about it.

Now, when the robber has made off with the goods, and all possible fear of personal violence has vanished, or can not possibly arise, it then becomes a question, merely, of the "prevention of crime." Society ignores all idea of carrying out the spirit of revenge that may fill the breast of the injured party—in fact punishes him, if he attempts to do so himself, as a criminal. Clearly, whatever may have been the guiding principle of the ancient law-giver, our present legislators do not attempt to administer to personal resentment. The object and reasons for the existence of government have been inquired into, and a scientific basis is gradually building for the great modern structure to rest upon. The passions are found to be the most unsafe guides. Only a few rules of law, relating almost wholly to domestic relations, rest upon them. The consequence is, that these relations figure most disgustingly in the proceedings of courts.

Yours respectfully,

W. C. Albro, LL. B.

Poughkeepsie, New York, *March* 19, 1880.

EDITOR'S TABLE.

MATTHEW ARNOLD ON COPYRIGHT.

THE question of international copyright, as we have maintained on all occasions, is for the people of this country a very serious one. It is commonly regarded that our present condition in respect to it is merely an imperfect state of things which nobody knows how to remedy, and which need not much disquiet us, as it is happily working very much to our advantage. Why, it is asked, should we pick a quarrel with our own bread and butter, especially when the bread is buttered so thickly on both sides?

The reason why the matter is grave

is that the bread and butter are both stolen, and because theft is bad for those who lose their property, and worse for those who get it. A nation can not tolerate palpable dishonesty without vital injury to itself. One injustice leads to another, and demoralization spreads. Selfish advantages openly override correct principles, and then, worst of all, come the mental obliquity and confusion resulting from attempts to palliate and excuse injustice. If a flagrant wrong is long and widely practiced, there will always be plenty to rally for its defense—some dishonestly, from interested motives, and others with a senseless sincerity from innate crookedness, cloudiness, or eccentricity of mind. These crotchety, whimsical, and erratic intellects are found both at home and abroad, and they often prove capable of doing considerable mischief.

Matthew Arnold affords the last example of this mental freakishness, in his article on the copyright question, in the March "Fortnightly Review." The article has excited a good deal of comment, and no little commendation, but it seems to us eminently unsatisfactory. We find no fault with the conclusion at which he arrives, which was intimated years ago, when he joined fifty other English authors in recommending the scheme of international copyright, which originated in this country, and which there has been much reason for thinking could be practically carried out. But, while Mr. Arnold's decision is sound, we think it would have been wise if he had withheld his reasons for it. They are not such as will bring other men to the same result. They are such as will carry other men to the opposite conclusion. So far as logic is concerned, Mr. Arnold takes substantially the same ground as that taken by Mr. J. M. Stoddart, the Philadelphia publisher, who is engaged in pirating the "Encyclopædia Britannica." They both agree that nobody's rights are violated, as there are no rights in the case. Mr. Arnold's point of view in regard to copyright is quite his own. Here, as everywhere else, he is haunted by the spirit of "Philistinism." The undesirable practice of appropriating an author's works is a miserable piece of middle-class indelicacy. "The spirit of the American community and Government is the spirit, I suppose, of a middle-class society of our race, and this is not a spirit of delicacy. One could not say that in their public acts they showed in general a spirit of delicacy; certainly they have not shown that spirit in dealing with authors."

Mr. Arnold pursues this thought more fully. He says: "The interests of English authors will never be safe in America until the community as a community gets the sense in a higher degree than it has now for acting with delicacy. It is the sense of delicacy which has to be appealed to, not the sense of honesty. Englishmen are fond of making the American appropriation of their books a question of honesty; they call the appropriation stealing; if an English author drops his handkerchief in Massachusetts they say the natives may not go off with it, but if he drops his poem they may. This style of talking is exaggerated and false; there is a breach of delicacy in reprinting the foreigner's poem without his consent, there is no breach of honesty. But a finely touched nature, in men or nations, will respect the sense of delicacy in itself, not less than the sense of honesty."

Now, there can not be the slightest objection to this appeal to the sense of delicacy and honor in the effort to secure legal protection to the property of authors. It may be that there are those who would be moved by this consideration and no other; and if Mr. Arnold had been content to devote his paper to this view of the case, there would have been no reason to complain of him.

But, instead of strengthening the case, he shifts its ground in such a way as completely to surrender it. It was not at all necessary to his argument from "delicacy" that he should deny the bearing of moral considerations upon the question; but this he has done in a way that, so far as it has any influence at all, will strengthen the hands of the inveterate enemies of copyright. He intensifies the discords upon a subject which many seem bent upon befogging and distracting by all the arts of ingenious sophistry. He professes to be friendly to copyright, and then reasons his way to the destruction of all copy*right* by denying that there is any right or wrong in the matter. This reasoning is as follows: "Now, for me the matter is simplified by my believing that men, if they go into their own minds and deal quite freely with their own consciousness, will find that they have not any natural rights at all. And as it so happens with a difficult matter of dispute, so it happens here: the difficulty, the embarrassment, the need for drawing subtile distinctions and for devising subtile means of escape from them when the right of property is under discussion, arise from one's having first built up the idea of natural right as a wall to run one's head against. An author has no natural right to a property in his production. But then neither has he a natural right to anything whatever which he may produce or acquire. What is true is, that a man has a strong instinct making him seek to possess what he has produced or acquired, to have it at his disposal; that he finds pleasure in so having it, and finds profit. The instinct is natural and salutary, although it may be over-stimulated and indulged to excess. One of the first objects of men in combining themselves in society has been to afford to the individual, in his pursuit of this instinct, the sanction and assistance of the laws so far as may be consistent with the general advantage of the community. The author, like other people, seeks the pleasure and the profit of having at his own disposal what he produces. Literary production, wherever it is sound, is its own exceeding great reward; but that does not destroy or diminish the author's desire and claim to be allowed to have at his disposal, like other people, that which he produces, and to be free to turn it to account."

Mr. Arnold here discredits as groundless and illusory that whole order of ethical conceptions which we have been wont to regard as fundamental in relation to human conduct. Whether he scouts all morality does not appear, but he denies it at least in one class of human actions. Though dealing with transactions between man and man which involve the ideas of "possession," "appropriation of property," "robbery," "criminality," "penalty," etc., he never refers to such things as "justice," "equity," "duty," "right," and "wrong," or any principles of obligation. Though all men recognize these conceptions, though the government of society is founded upon them, and though men are fined, imprisoned, and strangled, accordingly as their actions fail to conform to these fundamental ideas, yet Mr. Arnold airily waives them all aside as irrelevant and impertinent in relation to the subject he is discussing. The reader will notice the wordy circuits by which he avoids all the moral elements of the inquiry. To get rid of any question of rights in this matter, he plucks up by the roots and casts to the winds all natural rights. To him who claims a right to life he virtually says: "Oh! no; you have an instinct to live, which is natural and salutary. You find pleasure in life, but it is its own exceeding great reward, and society graciously allows you to have it at your disposal; but you have no natural right in the matter." He maintains that a man has no right of property in his productions, except "so far as the law may choose

to create one for him." But is there no right or wrong in the nature of things by which the law itself is to be shaped, and to which it is the object of all law to give effect? A man creates a work of value into which he has put his time, exertion, substance, and his very blood. Has he a right to the property he has produced against those who covet it? It shall be as the politicians vote, argues Mr. Arnold: "If the ayes have it, he has; if the noes have it, he has not." This is not creditable. Mr. Arnold should cultivate a more intimate communion with the "power that makes for righteousness."

Much is made in this article of the difficulty of securing property in books. Government is, of course, a very imperfect agency, and only partially secures any of its objects. But all other difficulties are as mole-hills to mountains compared with that which Mr. Arnold lends his influence to increase and strengthen.

SCIENCE NOT ATHEISTIC.

We recommend those thoughtless theologians who think they are doing God service by arraying modern physical science against him and charging that it is atheistic, to read the article entitled "God and Nature," by the Lord Bishop of Carlisle. He utters a timely and much-needed rebuke to his careless brethren on this subject. We have been amazed at the fatuity of many divines in the course they have pursued upon this question. Their predecessors have been more wise, and have generally recognized that "the study of nature led up to nature's God"; but now, on the contrary, we are assured that the study of nature leads to the denial of God. What on earth our theological friends are to gain by spreading the belief that physical science is fundamentally irreligious by renouncing and subverting all conception of the Deity, we are at loss to understand. Physical science is not to be put down in this way. It is a great phase of man's mental progress and is destined to increase in influence in an accelerating ratio. There is no doubt, furthermore, that its growth is an invasion of the domain illegitimately held by theology in the past, and threatens the ascendancy of theological systems and ideas. It is hardly to be expected that professed theologians can view this change with complacency, but that affords no excuse for getting into a passion with science, and striving to array religious prejudices against it. Our friends should not forget that the "modern science" upon which they expend their denunciations is a great body of accredited and impregnable truth, and that it is a somewhat serious matter to declare and reiterate the accusation that it is atheistic in its spirit and influence. How far is this from asserting that the demonstrative truth of nature is against the existence of God!—and if scientific men reply to the theologian, "Very well, you know best," where will rest the responsibility?

The Bishop of Carlisle sees that this is a mistaken policy. He says, "It is not desirable that the reproach of atheism should be thrown about rashly"; and, what is more important, he points out that as commonly done it is not true. A very slight examination of the conditions of thought in scientific pursuit forbids the current theological conclusions. He draws a valid distinction between the legitimate, proper, and logical attitude of the scientific mind toward the conception of Deity and the atheistic state of mind; and he strives to mark this distinction by the introduction of a new term. He says: "It seems to me that we want a new word to express the fact that all physical science, properly so called, is compelled by its very nature to take no account of the being of God; as soon as it does this it trenches upon theology and ceases to be physical science. If

I might coin a word, I should say that science was *atheous*, and therefore could not be *atheistic;* that is to say, its investigations and reasonings are by agreement conversant simply with observed facts and conclusions drawn from them, and in this sense it is *atheous*, or without recognition of God. And because it is so, it does not in any way trench upon *theism* or *theology*, and can not be *atheistic*, or in the condition of denying the being of God. Take the case of physical astronomy. To the mathematician the mechanics of the heavens are in no way different from the mechanics of a clock. It is true that the clock must have had a maker; but the mathematician who investigates any problem connected with its mechanism has nothing to do with him as such. The spring, the wheels, the escapement, and the rest of the works are all in their proper places somehow, and it matters nothing to the mathematician how they came there. As a mathematician the investigator of clock-motion takes no account of the existence of clock-makers; but he does not *deny* their existence; he has no hostile feeling toward them; he may be on the very best terms with many of them; it may be that, at the request of one of them who has invented some new movement, he has undertaken the investigations. Precisely in the same way the man who investigates the mechanics of the heavens finds a complicated system of motion, a number of bodies mutually attracting each other and moving according to certain assumed laws. In working out the results of his assumed laws, the mathematician has no reason to consider how the bodies came to be as they are; that they are as they are is not only enough for him, but it would be utterly beyond his province to inquire how they came so to be. Therefore, *so far as his investigations are concerned*, there is no God; or, to use the word above suggested, his investigations are *atheous*. But they are not *atheistic*."

For the further working out of this conception in his article, the Bishop must be held responsible. We only call attention to the position here assumed, as illustrating the progress of a liberal and rational theology.

THE LONDON "TIMES" ON "CEREMONIAL INSTITUTIONS"

The attitude of the British press for the last twenty years toward the writings of Herbert Spencer is a curious study. It was natural enough that Spencer could not get a publisher who would take the pecuniary chances in an interminable system of philosophy opposed to all other systems, and based upon an unaccepted and repugnant doctrine; and so nothing remained for him but to publish himself. The works, at any rate, were thus put squarely upon their merits. The powerful agency of publishers in influencing the press was dispensed with; and, as Spencer was the last man to lift a finger for the procurement of critical favor, his publications were left to themselves, editors being neither directly nor indirectly bribed, placated, or flattered. The consequence was that, with but few exceptions, the books were assailed with such reckless misrepresentations that Spencer was compelled to stop sending copies to the press. Nor did he resume the practice until increasing public interest in his labors coerced critics into more decency and fairness.

Some influential journals, however adopted the policy of silence, ignoring Spencer's books altogether. The "Spectator" has adopted this plan. Not a single one of this author's works has ever been reviewed in that journal; and that they were not thought to be worth reviewing could not be alleged, because the chief editor of the "Spectator," Mr. Hutton, went out of his way to attack Spencer's ethical views in an essay read before the Metaphysical So-

ciety, and which he subsequently printed in "Macmillan's Magazine."

The London "Times" also, the organ and oracle of British opinion, has illustrated its idea of fair-play by never criticising or noticing any of Spencer's volumes. These volumes were being widely read; they were molding the opinions of thinkers; they were becoming influential in the universities; they were elaborately criticised in the reviews; they were replied to in numerous pamphlets and books; they were translated into all the Continental languages; they were guiding scientific investigation, and familiarizing the cultivated mind of the age with a new order of ideas, but they were never recognized by the London "Times" any more than if they were non-existent. George Henry Lewes said of Spencer that he alone of all British thinkers had organized a philosophy; but the "Times" had no information about it. The meanness of its course is the more palpable, as it never had any principles of its own to maintain, and said what it pleased on any subject; while Spencer was engaged upon a most formidable undertaking, with immense odds against him. But the "Times" has given in at last. Now that the world's verdict has been decisively rendered, it pluckily determines that this author's work must have attention.

And so it breaks the long silence by an elaborate review of "Ceremonial Institutions." There is nothing noteworthy about the article except the significance of its appearance in the "Times's" columns, and the ludicrous perplexity of the writer's position. He writes as if he thought his readers were asking, after twenty years' reticence, Why are you moved to speak now? The book he reviews is part of a series of works which can not be critically understood without reference to the previous volumes. But there is no reference to them—no intimation as to how Spencer was led to deal with the subject. It is, of course, easy in this way to make such a work appear very deficient, but the critic could do it no justice without convicting the journal in which he wrote of former inexcusable neglect. However, the "Times" has found it desirable to change its tactics, and it will no doubt do better next time.

LITERARY NOTICES.

ENGLAND: HER PEOPLE, POLITY, AND PURSUITS. By T. H. S. ESCOTT. New York: Henry Holt & Co. 1880. Pp. 593. Price, $4.

IN these pages Mr. Escott has endeavored to make a survey of modern England, presenting all the salient features of English social, political, literary, and industrial life in such a way as to give a correct picture. Of course, so large a subject can only be given in outline in this compass, but by a judicious use of materials a very large mass of information has been introduced and the subjects treated in approximately their relative proportions. The life and characteristics of the English village; the position and duties of the great landholders; rural administration and municipal government; the law-courts, the legislature, the crown, as well as the official system, all receive more or less attention. Hotel and traveling facilities and popular amusements receive such notice as their importance warrants. Considerable space is given to the condition and prospects of the working-classes, the relations they hold to the other classes of English society and to the state, and the conditions and some of the causes of poverty among them, and the means employed to alleviate it. Educational systems and measures, the structure of society, the relations of society to politics, commercial and financial features, are treated more or less fully, while a large place is given to the intellectual life, religious, scientific and literary. One of the most noticeable chapters in the book is that devoted to British philosophic thought. It is contributed by Mr. W. L. Courtney, of Oxford, and is an able and appreciative review of the subject. He recognizes fully

the importance of the work that has been done by Mr. Herbert Spencer, and gives him the foremost place as a systematic thinker, not only among his contemporaries, but among all English thinkers of the century. Of the other two workers in psychology who have claims to a position somewhere near the level of Mr. Spencer, George Henry Lewes and Alexander Bain, Mr. Courtney gives to Mr. Lewes the higher place. The book is a very readable one, and, from the extent and variety of its information, will prove attractive to a large class of persons.

THE INTEROCEANIC CANAL AND THE MONROE DOCTRINE. New York: G. P. Putnam's Sons. 1880. Pp. 118. Price, $1.

IN the pages of this little volume will be found compiled a considerable amount of information concerning the commercial importance of the interoceanic canal, the history of the various schemes for constructing it, and its relation to the interests of the United States. It is a timely summary of the leading general facts regarding the enterprise, but does not go fully into the discussion of the merits of any particular project. The book was evidently prepared for an emergency—the arrival of De Lesseps in this country—with the design of heading him off in his project. Unless there was an unavowed and sinister purpose in its publication, we can not see why it should have been issued anonymously. If its author was interested in a rival scheme, and a man of mark, he would very naturally withhold his name from the title-page; but, in treating a great public interest like this in an open and candid way, there can be no occasion for the concealment of authorship. That the book is aimed at De Lesseps is shown by the prominent use the writer makes of the Monroe doctrine, as a means of defeating a foreign project. We showed last month the humbug of this Monroe-doctrine pretext, and there are plenty of indications that the public is beginning to understand how utterly it is perverted when applied to the cutting of a ship-waterway across the American Isthmus. The book is narrow in spirit, and advocates a bigoted and illiberal national policy, which, if carried out, would become a scandal to American history.

FREE SHIPS. By Captain JOHN CODMAN.

LABOR-MAKING MACHINERY. By FREDERICK PERRY POWERS. Price, 25 cents each.

THE ACTION OF THE UNITED STATES TARIFF. By ALFRED TYLOR, F. G. S. New York: G. P. Putnam's Sons. 1880. Price, 10 cents.

IN issuing the series of "Economic Monographs," of which the first two pamphlets above are numbers, the Putnams are rendering a valuable service to popular education, in a direction in which enlightenment is greatly needed.

The essay on "Free Ships" is an able discussion of the reasons for the decline of the American carrying-trade, in which the folly and stupidity of our legislation on the subject are clearly shown. Captain Codman points out that this legislation has been continually in the interests of a handful of ship-*builders*, while the vastly larger interests of the ship-*owners* have been systematically ignored. At the time when the carrying-trade of the world was done in wooden ships, Americans were able to build the best and cheapest ships; and England, recognizing the interests of the ship-owners as rightly predominant over those of her ship-builders, allowed her merchants to freely purchase ships wherever they pleased. Under this policy, her carrying-trade thrived, and has continued to thrive. And when American merchants were placed under the same conditions—as they were when our ships were the best that could be had—our carrying-trade also thrived. When iron supplanted wood in ship-construction, and we could, in consequence, no longer build as cheaply as England, our legislators had not the wisdom to follow the policy that had proved so successful in England. Instead of allowing our merchants to purchase vessels where they could get them cheapest, they began fostering the ship-building interest—not by putting a heavy duty on foreign ships, but by prohibiting the purchase of such ships at all. Those engaged in other protected industries have been content with the imposition of onerous duties on competing foreign products, but, if one prefers these, he is at liberty to buy them and pay the duty. This sort of protection is not enough, however, for the ship-builders; nothing short of absolute prohibition has been able to satisfy them. The inter-

ests of hundreds of merchants have been ruthlessly sacrificed to serve those of two or three men!

To his essay proper, Captain Codman adds a review of the plans for reviving our carrying-trade put forth by Senator Blaine and Secretary Sherman. The pith of the Captain's argument comes out in the following paragraph in the review of Senator Blaine: "He tells us how Germany has prospered. She has increased her tonnage from 166,000 to 950,000 tons in twenty years, while ours has decreased in that time until it has nearly gone out of sight. Her increase has chiefly been in iron screw-steamships. Where did Germany get those steamships with which she has taken away from us our carrying-trade? She bought them. Why did she buy them? Because she could buy them cheaper than she could build them. Why did she not wait, as we are doing, until they could be built cheaper than they could be bought? Because, in the mean time, England, or some other nation who could buy them, would have the carrying-trade. Who has prevented us from imitating Germany; in fact, from maintaining our carrying-trade, which she has taken from us? Who, but Mr. Blaine and his school of protectionists, who have reversed the fable of the dog in the manger; for the horse has forced the dog to eat his hay?"

Though Captain Codman strongly urges the adoption by Congress of the twenty-first section of Mr. Wood's late tariff bill, he insists that very much more than this is necessary to place our carrying-trade in a healthy position. We not only need the freedom to buy ships where we can get them best and cheapest, but we also need maritime laws that will place us on an equality with our most favored rivals.

In his essay on "Labor-making Machinery," Mr. Powers combats the frequently advanced notion that machinery displaces the workman and renders employment scarce. He insists, on the contrary, that it has been in all cases a great benefit to the laborer, and has multiplied his opportunities of labor, and made his employment steadier. The results of his study of the question he sums up as follows: 1. Machinery has reduced the cost of food, or at least prevented its rising with the increase of population, and has also reduced the cost of clothing and other manufactured goods, conferring two benefits upon the laboring classes. 2. The introduction of machinery has increased the demand for labor. The result has been the increase of the number of persons employed in excess of the increase of population, and an increase in the rates of wages beyond the increase in the cost of living. 3. Machinery has effected a marked reduction in the length of the working-day, and has reduced the amount of muscular exertion requisite in many branches of industry. 4. In so far as machinery has conferred less benefit on American laborers than might have been anticipated, it is attributable chiefly to the fact that European laborers have poured into this country in a flood, especially since 1845, since which time the greatest advances in the introduction of machinery have been made.

The third of these pamphlets is a reprint of a letter by Mr. Tylor to the London "Economist," in which he points out a curious and unsuspected effect of the American tariff. He maintains that, besides the result which a high protective tariff has in increasing the prices of those things protected, it has also the effect of lowering the prices of those things that do not come within its scope. By comparison of the prices of wheat, cotton, and oil through a number of years, he shows that, in consequence of our tariff, Englishmen have been able to procure these indispensable articles from us for considerably less than they could have done in a condition of free exchange. "Wheat," he says, "which had averaged fifty-two shillings per quarter for eighteen years in the several markets of Great Britain, in consequence of the American supply has only averaged forty-eight shillings from 1874 to 1879, and yet these have been years of European scarcity. . . . Merchants were surprised, for no one reckoned upon the effect of the American import duties (when limiting import from Europe) in depressing the price of their exports. They had calculated, in the usual way, that, with an increased food-demand of eighty per cent. from Europe, there should certainly be a great advance in price, instead of

which a fall of ten per cent. from the previous average price occurred after 1874." Of cotton, he says: "In 1860 and 1861 the average consumption of cotton in Great Britain was 1,040 million pounds, against 1,229 million pounds in 1878. The price is slightly lower now than it was even in 1860–'61. When we consider the enormous competition for cotton, and the British plant provided for working up nearly 200 million pounds per annum, nothing but the want of the American market for finished goods can have kept the price of cotton down to such a very low figure as that prevailing, almost lower than it ever touched before. . . . One consequence" of this is that "the American cotton-grower has latterly got the minimum instead of the maximum price for his article." Mr. Tylor finds that this fall in price also applies to petroleum, and he humorously observes that the British Government "ought to make a strong remonstrance on this subject. We are at the same time indebted to the United States for their cheap grain, cotton, and petroleum, sold at the cost of production to us, in consequence of this unjust tariff." The view of the subject advanced by Mr. Tylor is well worth the attention of our legislators and economists, and, if borne out by fuller inquiry, will constitute another of those facts which increasing experience is adding to our knowledge, showing the folly of tariff restrictions.

REPORT OF THE DEPARTMENT OF PUBLIC WORKS OF THE CITY OF NEW YORK. For the Quarter ending June 30, 1879. With a Special Report on the Subject of Water Supply.

THE feature of this report that gives it an interest to the general public of New York is the very full and elaborate statement of the condition of the water-supply of the city. The Commissioner, Mr. Campbell, points out in it that the present means of furnishing water are and have been for some years inadequate, and that there is danger, in case of any unusual demand, or a continued drought such as occurred in 1877, of the city suffering from an insufficient supply. The present supply is obtained, as is well known, from the Croton River, through the aqueduct of that name. This was constructed to deliver sixty million gallons daily, but for the past eight or nine years it has been called upon to do a much larger service. The present demand for water is between ninety and one hundred million gallons per day, with an increasing demand of two millions per day for each year. The present system is able to supply this demand only by working much closer to the limit than is advisable. When the new reservoir at the middle branch of the Croton and the dams and flumes to draw upon all the available lakes and ponds in the Croton basin are completed, there will be a storage capacity of nine billion gallons, which will be sufficient to fill the present aqueduct to the extent of its capacity; and, to increase the supply, other conduits, either from the Croton basin or elsewhere, will have to be constructed. With a view of determining what sources of supply were available, surveys have been made of the watershed of the Bronx and Byram Rivers, and of that of the Housatonic River, the results of which are given in the present report. The surveys of the Bronx and Byram Rivers district show that tapping the Bronx a few miles above White Plains, the area drained, including the Rye ponds, is 13·33 square miles, and that the like area for the Byram is 8·66 square miles, giving a total of twenty-two square miles. The waters of the Byram can be diverted into the Bronx by means of a tunnel about twenty-six hundred feet in length, and some open cutting. By constructing proper reservoirs and dams, Mr. G. W. Birdsall, the engineer reporting on the proposed work, estimated that thirty-five hundred million gallons can be stored, and that an average daily supply of twenty million gallons can be obtained from this source. The estimated cost of the work is something over twenty-six hundred thousand dollars. This source of supply will only suffice for a few years, after which a further supply will become necessary. With a view of determining its value as a source for such further supply, the survey of the Housatonic district was made. The work was in charge of Mr. Horace Loomis, who has submitted an excellent report upon the results of his investigations. He found that the waters of this river could be brought to the head of

the Croton by three different routes, one of a little less than fifteen miles, another nearly twenty-seven miles, and the third forty-one miles. The shorter route is regarded as impracticable, as the water would have to be raised one hundred and six feet to the conduit. The third route, though the longest, is considered the best for a permanent work of this character. It would consist of thirty miles of open canal, two and one half miles of tunnel, and eight miles of natural watercourses. The area drained by the Housatonic above the point where this conduit would join it is six hundred and thirty-one square miles, and the water that could be delivered into the Croton is estimated at one hundred million gallons daily. The cost of this work to the head of the Croton River is estimated at a little over two million dollars. It is considered that, with the auxiliary supply which this river would furnish, the water-supply of New York would be assured for a number of years. Mr. Campbell urges the necessity of early action, that a work which will necessarily consume a considerable time may be commenced in season to meet the continually augmenting demand for water.

THE THEOSOPHIST. A Monthly Journal devoted to Oriental Philosophy, Art, Literature, and Occultism: embracing Mesmerism, Spiritualism, and other Secret Sciences. Conducted by H. P. BLAVATSKY. Subscription price, 10 rupees. Published, 108 Girgaum Back Road, Bombay, India.

THIS periodical, which was started last October, seems to be the organ of the Theosophical Society that has existence both in New York and Bombay. Colonel Henry S. Olcott is its president and Madame Blavatsky its corresponding secretary. Bombay, we suppose, is now headquarters, as the parties mentioned have recently left New York and established themselves in Bombay, where their organ is now printed. "The Theosophist" is printed in English, but claims to have a universal patronage, being subscribed for in every part of India, in Ceylon, Burmah, on the Persian Gulf, in Egypt, Australia, North and South America, and the chief European countries. Of its contents it is somewhat difficult to speak. A large proportion of its contributions are from writers whose names betray an English origin, but there are many from learned natives of India. We should say that the journal is devoted to mysticism, and is perhaps the purest and most perfect anti-scientific periodical that has ever been started.

Its ideal virtue is evidently to believe. We can gather no intimation that there is any check to this process, nor anything too wild, absurd, or extravagant to be credited. One would think that Colonel Olcott and Madame Blavatsky could have found exercise enough for credulity in New York. But they have sought an Oriental sphere where they can revel in a far richer and wider field of superstition.

It seems there is a Hindoo spiritualism akin to American spiritualism, but still arrogating superiority over it. Mr. Rao Bahadur Janardhan Sakharam Gadgil, LL. B., F. T. S., in a communication to the December "Theosophist," thus contrasts the two systems:

> The spiritualists of America and Europe have this truth (the survival and return of spirits) phenomenally demonstrated to them, and so far Eastern philosophy welcomes the movement. But beyond this it can not go; for it finds little reason to congratulate the spiritualists upon the new ideas and aspirations they put forth. That death is the mere separation of the corporeal from the *Jiva*, or soul, that animates it, is a truth admitted in all schools of Oriental philosophy. The Bhagwatgita says that the *Jiva*, which is a part and parcel of myself, that is, Brahm, leaves the corporeal body at the time of death, and it draws in and takes with it the mind and the senses, just as the breeze of air that touches and leaves a flower bears off its perfume. So far Oriental philosophy and Western spiritualism are at one. But it appears that Western spiritualists are drifting into the belief that every human soul, after its severance from the corporeal body which it animated on this earth, remains for ever without another corporeal body; that all human souls can and some do make themselves manifest to living human beings either through the bodies of mediums or by assuming, temporarily, objective forms themselves; that this state of existence is better than the earthly one; and that in their corporeal existence they will develop and attain to the degree of final perfection. Now, Hindoo philosophy and religion teach differently on every one of these points. Though they admit that some human souls may continue for a long time without another corporeal body, still this is the lot of comparatively a few of those only who, during their existence on this earth, led a life of sensual appetites and who died prematurely with the intensity of those car-

nal desires unabated, and surviving separation from their gross bodies.

It is such souls only that are considered to stick to the earth and become what are called *Pishachas*, or what the Western spiritualists miscall "spirits"! But even these are not considered to continue in this state of existence for ever, nor is this state of existence considered in any way desirable. With regard to the majority of human souls, it is held that, according to their holy or unholy deeds and desires in this life, they go either to higher and better worlds, ending with *Brahma loka* by the *archirádi márga*, or to the nether worlds by the *yama márga*. The former are considered to be temporary elevations to better existences, the latter to worse existences than in this world in human shape.

But the state of existence known as *Pishacha yoni* is regarded in the Hindoo system of philosophy and religion as the most horrible and pitiful that the human soul can enter. The reason of it is that it is the state that comes over the human soul as the result of the baser desires having preponderance at the time of separation from the corporeal body; it is the state in which the capacities for the enjoyment of sensual pleasures are in a developed state, but the soul lacks the means of physical enjoyment, viz., a corporeal body; it is the state in which the soul can never make progress and develop into better existence. It is considered that in this state the soul, being deprived of the means of enjoyment through its own physical body, is perpetually tormented by hunger, appetite, and other bodily desires, and can have only vicarious enjoyment by entering into the living physical bodies of others, or by absorbing the subtilest essences of libations and oblations offered for their own sake. Not all *Pishachas* can enter the living human body of another, and none can enter the body of a holy man—that is, an ascetic or adept in occultism.

Annual Report of Harvard College Observatory.

The Director of the Astronomical Observatory of Harvard College announces in his annual report for 1879 that a subscription of five thousand dollars a year for carrying on the work of the observatory for five years has been completed. The astronomical work of the year at the observatory includes photometric measurements of Japetus, Saturn's outer satellite, photometric observations of the eclipses of Jupiter's satellites, the photometric observation of faint stars as aids to the formation of standards of magnitude, measurements of the planetary nebulæ, and the completion of the observation of the zone of eight thousand stars between 50° and 55° north, which has been going on for eight years. A work of some magnitude has been undertaken in the determination of the light of all the stars visible to the naked eye in the latitude of Cambridge. The report is printed at the University Press, Cambridge, Massachusetts.

History of the English Language. By T. R. Lounsbury, Professor of English in the Sheffield Scientific School of Yale College. New York: Henry Holt & Co. 16mo, pp. 371. Price, $1.

The languages allied to the English are sketched in an introductory chapter. The main subject is treated under the two heads of "General History" and the "History of Inflections." The former part is of more general literary interest. In it we notice a carefully weighed estimate of the effect which the introduction of the mass of French words in the fourteenth century has had on the character and capacity of the language. The second part has been prepared more particularly for special students.

The Mound-Builders: Being an Account of a Remarkable People that once inhabited the Valleys of the Ohio and Mississippi, together with an Investigation into the Archæology of Butler County, Ohio. By J. P. McLean. Illustrated with over One Hundred Figures. Cincinnati: Robert Clarke & Co. 1879. 12mo, pp. 233. Price, $1.50.

As to the general subject, this work attempts to present all the essential facts that have been gathered, without burdening the reader with elaborate speculations. The chapter on Butler County, Ohio, gives the fruits of the original researches and surveys of the author, which he made as thorough and exact as possible, in a county which was once an important seat of the mound-builders. Most of the engravings were made especially for the work, and to them is added a sectional archæological map of Butler County.

Insect Lives, or, Born in Prison. By Julia P. Ballard. Cincinnati: Robert Clarke & Co. Small 4to, pp. 97. Illustrated. Price, $1.

This little work is intended to present the facts of the life-history of moths and butterflies in such a manner as to interest children, and lead them to study and observe for themselves. The author has relied upon and described her own observations.

EYESIGHT, GOOD AND BAD. By ROBERT B. CARTER, F. R. C. S. London: Macmillan & Co. 1880. Pp. 262. Price, $1.50.

IT has been the object of Dr. Carter, in preparing this work, to furnish such information on the structure and function of the eye and to give such hints on the care of the eyesight as everybody should know and take heed of. Experience as an ophthalmologist has shown him the need of such a work, as a large portion of the time of such a practitioner is, he says, "occupied, day after day, in repeating to successive patients precepts and injunctions which ought to be universally known and understood." The work considers the structure of the eye, the action of lenses in forming images, the like action of the eye, and the various ways in which these images are distorted, imperfectly formed, etc., according as the eye is defective. The care of the eyes, the effect on them of natural and artificial illumination, and some practical hints on spectacles, are among the subjects treated. The volume will be found valuable in every household, both as a means of obtaining such knowledge in regard to the eyes as it is important to know and as a convenient reference-book.

THE PERCEPTION OF SPACE AND MATTER. By Rev. JOHNSTON ESTEP WALTER. Boston: Estes & Lauriat. 1879. Pp. 451.

IN this volume Mr. Walter has propounded a theory of perception differing widely from any of previous writers. He reviews and criticises the theories of Reid, Hamilton, Bain, and Spencer, none of which are to his mind satisfactory explanations of the mode in which we perceive the external world. He denies that the existence of such a world is immediately given in consciousness; or that from our experience of force an idea of an extended external cause can arise; or that the postulating of laws of thought, constraining us to invest the external world with space relations, offers a satisfactory solution of the problem of perception. That which the mind knows immediately is only the way in which it is affected and the relations between those various affections. These relations are, however, only relations of sequence, and there are no elements given in these time-relations by which the mind can arrive at space-relations. In order, therefore, that the mind should be able to clothe external things with space-attributes, it must have immediate knowledge of spatial relations among its own sensations—that is, mind must be extended. "There must be," he says, "something really capable of prompting the mind to look outward. But this condition is not supplied in any mysterious innate laws of cause and effect or of association. It is supplied in the immediate perception of spatial exteriority within the sphere of the mind itself or of its phenomena. . . . We come to think of a cause, or causes, external to and independent of the mind, for the reason only that we previously have had the immediate experience of the mind acting as an external cause, so to speak, on mind." This doctrine of mind being an entity occupying space he regards as satisfactorily resolving the difficulties that have hitherto remained irresolvable. The work is original in its results, lucid in its exposition, and direct in its arguments, and will be found a valuable and interesting discussion of the subject.

THE METAPHYSICS OF THE SCHOOL. Vol. I. By THOMAS HARPER, S. J. London: Macmillan & Co. 1879. Pp. 592. Price, $5.

IN the reaction of modern thought against the discussions and teachings of the schoolmen, Mr. Harper thinks there has been little or no discrimination between the good and the bad, and that with some that was frivolous there has been cast aside much that was of value. He avows himself a disciple of the scholastic doctors, and, in the preface to the present volume, undertakes to show that their metaphysics does not deserve the unstinted reproach cast upon it, either on account of its terminology, or of the subjects discussed, or of the manner in which the discussions were carried on. He has, therefore, undertaken to present the essential parts of the writings of the scholastics, especially those of St. Thomas and Saurez, in a form acceptable to modern readers. The exposition will run through four large volumes, of which this is the first.

VOCAL PHYSIOLOGY AND HYGIENE. By GORDON HOLMES, L. R. C. P., Edinburgh. Philadelphia: Presley W. Blakiston. 1880. Pp. 266. Price, $2.

THE object of this work, the author states in his preface, "is to furnish persons who make an artistic or professional use of the vocal organs with a concise but complete account of those scientific relations of the voice, physical and medical, which are generally only alluded to cursorily, or passed over altogether, in works on elocution and singing." The author gives an historical review of the origin and progress of vocal culture, and considers the relation of sound to the voice, the physical construction of the vocal organs, their physical action, the physiological principles involved, and the hygiene of the voice. Under this latter head he considers the effect on the voice of the use of stimulants and narcotics, the diet, the habits of life, of exercise, etc., and gives some directions for its care and treatment when not in good condition.

ELECTRIC INDUCTION. By J. E. H. GORDON, B. A. London: Sampson Low & Co. 1879. Pp. 141.

IN the four lectures before the Royal Institution contained in this little volume, Mr. Gordon has undertaken to present such facts in electric induction as go to show what it is, and how it is propagated from the excited to any other body. The question, he says, which for fifty years physicists have been trying to answer, is now, through the experimental and mathematical researches of recent years, in a fair way of being answered, and the object of these lectures has been to present some of the data and reasoning upon which this answer rests. According to him, the present position of science on the subject is, that induction is propagated through space by means of undulations in an ether in a manner similar to light, and all that is at present known points to the ether being the same for both excitations, and the difference of the phenomena being due to differences of vibration. An induced body is in a state of strain which in a good conductor is being constantly relieved, and which in a poor conductor is not so relieved. The lectures, when delivered, were illustrated with a number of delicate experiments, descriptions of which and cuts of the apparatus employed are given in the present volume. The lectures are an excellent example of that clearness and directness of statement by which a naturally abstruse subject is made intelligible and interesting to the lay reader.

THERAPEUTICS AND MATERIA MEDICA. By C. E. ARMAND SEMPLE, M. R. C. P. London. Pp. 60.

FORENSIC MEDICINE AND TOXICOLOGY. By W. DOUGLAS HEMMING, M. R. S. C. Pp. 72.

AIDS TO ANATOMY. By GEORGE BROWN, M. R. C. S., L. S. A. New York: G. P. Putnam's Sons. Pp. 64. Price, 50 cts. each.

THESE are volumes in the "Students' Aids Series," on subjects of technical interest only. In the preface to his volume Dr. Semple states that it is intended to be a companion to his "Aids to Chemistry." A long list of remedies is considered, the doses given following closely those in the "British Pharmacopœia."

In the second of the above volumes, Dr. Hemming considers the questions with which medical men have to be familiar in appearing to testify as experts in cases in law courts, and gives a large amount of information in a compact and concise form.

In "Aids to Anatomy" Dr. Brown has aimed to present the main facts of anatomy in such a way as to be most readily grasped and retained by the student, and to be of value to him in the work of dissection.

ANNUAL REPORT OF THE NEW YORK METEOROLOGICAL OBSERVATORY FOR 1878. By DANIEL DRAPER, Director. New York: John F. Hahn, Printer. 1879. Pp. 69.

THE year covered by this report completes the tenth of the existence of the observatory, and Mr. Draper gives a summary of its establishment and an account of what has been accomplished in this time. The report states the conditions under which the observatory was begun, gives short abstracts from the reports of each year, describes the different self-recording instruments made and used at the observatory, insists on the desirability of a new observatory, and closes with annual and monthly tables. The report is interesting through-

out, but that part of it descriptive of the apparatus is especially so. The instruments, all of which have been invented or improved by Mr. Draper, are fully illustrated and clearly described. An excellent idea of how meteorological inquiries are carried on may be obtained from the report by those interested.

WATER-COLOR PAINTING. By AARON PENLEY. New York: G. P. Putnam's Sons. 1879. Pp. 68. Price, 50 cents.

THIS little manual of water-color painting seems to have met with a very favorable reception from the public, as this is the thirty-seventh American edition, which is taken from the thirty-eighth English one. The Putnams issue the book as one of their "Popular Art Hand-Book Series," edited by Susan N. Carter, in excellent style. The book aims to instruct the student in the principles of the art, and to give such information regarding practice as to make it a valuable aid to proficiency in such work.

PROTECTION OF FORESTS A NECESSITY, by S. V. DORIEN, touches a subject of most important interest to the people of the United States. It reviews the condition of the several countries in Europe, past and present, as to forests, rainfall, and fertility, with the purpose of showing what is the actual effect of forests upon the humidity of the air and on the power of the soil to absorb and retain moisture. New York: B. Westermann & Co.

PROFESSOR LEVI STOCKBRIDGE, of Amherst, Massachusetts, has published a pamphlet containing an account of investigations which have been conducted at the Agricultural College Experiment Station at Amherst, on the rainfall, the percolation, and evaporation of water from the soil, the temperature of the soil and air, and the deposition of the dew on the soil and the plant. The experiments were conducted with apparatus of various designs devised with reference to the special objects sought in each and under a variety of conditions, and were made to bear on the question whether the moisture that is found in the morning on the surface of the soil and on plants is mostly derived from the air directly or from the soil.

IMPROVED DWELLINGS FOR THE LABORING CLASSES, THE NEED, AND THE WAY TO MEET IT ON STRICT COMMERCIAL PRINCIPLES IN NEW YORK AND OTHER CITIES (G. P. Putnam's Sons, New York), relates one of the most important social questions with which American cities, particularly New York, are concerned. It sketches the need of New York and the extent of it in this matter, and describes much good work that has been done in London, New York, and Brooklyn, in more than one way, for the improvement of tenement-houses and of the life of their occupants.

THE REPORT ON MAGNETIC DETERMINATIONS IN MISSOURI, MADE DURING THE SUMMER OF 1879, by FRANCIS E. NIPHER, Professor of Physics in Washington University, is accompanied with a map showing the declination lines so far as they have been determined, to which is added a map of the independent preliminary surveys of Professor Hinrichs in Iowa. The isogonic lines show considerable flexures which seem to bear a relation to the drainage systems of the regions.

PUBLICATIONS RECEIVED.

Hampton Tracts. Cleanliness and Disinfection, by Elisha Harris, M. D., pp. 19; and Our Jewels, by Mrs. M. F. Armstrong, pp. 27. New York: G. P. Putnam's Sons. 1879. Price, 5 cents each.

The Native Flowers and Ferns of the United States. By Thomas Meehan. Vol. II. Second Series. Parts 19 and 20. Philadelphia: The American Natural History Publishing Co.

A Dictionary of Music and Musicians. Edited by George Grove, D. C. L. Part 9. Vol. II. London and New York: Macmillan & Co. 1880. Price, $1.25 per part.

Report of the Chamber of Commerce of the State of New York on Railroad Transportation. New York. 1880. Pp. 24.

The Food of Birds. By S. A. Forbes. From "Transactions of Illinois State Horticultural Society." Vol. XIII. 1879. Pp. 57.

Historical Sketch of Henry's Contribution to the Electro-Magnetic Telegraph. By William B. Taylor. Washington. 1879. Pp. 108.

Money and a Measure of Value. By John F. Smith. Oak Lawn (Rhode Island) Home Publishing Co. 1880. Pp. 23. Price, 10 cents.

Three Approximate Solutions of Kepler's Problem. By H. A. Howe, A. M. Cincinnati Society of Natural History. Pp. 6.

A Plea for Cold Climates in the Treatment of Consumption. By Talbot Jones, M. D. Reprint from the "New York Medical Journal." Pp. 32.

"The Oriental and Biblical Journal." Edited by Rev. Stephen D. Peet. Quarterly. Vol. I. No. 1. January, 1880. Chicago: Jameson & Morse. Pp. 48. Price, $2 a year.

Annual Report of the Wisconsin Geological

Survey for 1879. By T. C. Chamberlain. Madison. 1880. Pp. 72.

The Cotton-Worm. By Charles V. Riley. Illustrated. Washington: Government Printing-Office. 1880. Pp. 144.

The Chinch-Bug. By Cyrus Thomas. With Map and Illustrations. Washington: Government Printing-Office. 1879. Pp. 44.

Therapeutic Action of Mercury. By S. V. Clevenger, M. D. Chicago: Knight & Leonard. 1880. Pp. 27.

Extra Meridian Determination of Time. By Ormond Stone, A. M. Cincinnati: Society of Natural History. Pp. 6.

Adulteration of Food. By Albert R. Leeds, Ph. D. From "Third Report of New Jersey State Board of Health." Pp. 18.

A Subject-Index to the Publications of the United States Naval Observatory, 1845-1875. By Edward S. Holden. Washington: Government Printing-Office. 1879. Pp. 74, 4to.

Health and Health-Resorts. By John Wilson, M. D. Philadelphia: Porter & Coates. 1880. Pp. 288.

Our Homes. By Henry Hartshorne, M. D. Philadelphia: Presley Blakiston. 1880. Pp. 149. 50 cents.

Brain and Mind. By Henry S. Drayton and James McNeill. New York: S. R. Wells & Co. 1880. Pp. 334. $1.50.

The Taxidermist's Manual. By Captain Thomas Brown, F. L. S. New York: G. P. Putnam's Sons. 1879. Pp. 204. $1.25.

A Guide to Modern English History. By William Cory. Part 1. New York: Henry Holt & Co. 1880. Pp. 276. $2.

Pay Hospitals. By Henry C. Burdett. Philadelphia: Presley Blakiston. 1880. Pp. 176. $2.25.

Chemistry, Inorganic and Organic, with Experiments. By Charles Loudon Bloxam. Philadelphia: Presley Blakiston. 1880. Pp. 688. $4.

POPULAR MISCELLANY.

Where to find the Crayfish.—Professor Huxley, in his valuable work on the crayfish, published in the "International Scientific Series," tells his readers to study the work with "crayfish in hand." In order that readers may be able to do this, the following localities are given, copied from Dr. Hagen's monograph on the *Astacidæ*, with some localities added by the author: *Vermont:* in affluents of Lake Champlain; at Burlington, Shelburne, Colchester, Chittenden County. *Massachusetts:* Western parts of the State, on the authority of Mr. S. H. Scudder. *New York:* Hudson River and its affluents; Newburg, Fishkill; in the Tioga, affluent of the Susquehanna; at Berkshire, Tioga County; Lake Ontario; Genesee River, at Rochester; Garrison Creek, near Oswego; Lake Oneida; Four-Mile Creek, near Sackett's Harbor; and Grass River, a branch of the St. Lawrence; also at Niagara. *New Jersey:* Essex, Schooley's Mountain, Morris. *Pennsylvania:* in Delaware River (Philadelphia), Schuylkill River (Carlisle, Reading); Susquehanna and its affluents (Hummelstown, Berwick); Ohio River (Pittsburgh). *Maryland:* Havre de Grace. *Virginia:* James River and its affluents (Petersburg), the Rappahannock (Fredericksburg), and Greenbrier River. *District of Columbia:* Georgetown. *North Carolina:* Beaufort. *South Carolina:* Wateree River, Charleston, and Summerville. *Georgia:* Athens, Milledgeville, Roswell. *Florida:* Pensacola. *Alabama:* Huntsville, Mobile. *Mississippi:* Mobile River, Monticello, Rootpond. *Louisiana:* New Orleans, Millikin's Pond. *Tennessee:* Lebanon. *Kentucky:* Mammoth Cave, Little Hickman, Hickman's Landing. *Indiana:* Wabash River (Delphi). *Ohio:* Cincinnati, Columbia, Dayton, Miami River, Kelley Island, Lake Erie. *Michigan:* Lake Superior, and reported from Lake St. Clair. *Wisconsin:* Sugar River, and also reported from Milwaukee. *Minnesota:* Collected by Professor Agassiz at Minnehaha Falls. *Iowa:* Mississippi River at Davenport and Burlington. I have found it in greatest abundance at Dubuque. *Illinois:* Chicago, Evanston, Ogle County, Lawn Ridge, Basson Pudge, Peoria, Athens, Quincy, Belleville, Illinois River and its affluents. *Missouri:* St. Louis, and Osage River. *Arkansas:* One species reported, locality unknown. *Texas:* Between San Antonio and El Paso del Norte. *Nebraska:* One species reported, without locality. *Washington Territory:* Puget Sound. *Oregon:* Astoria, Columbia River, Lake Klamath. *California:* San Francisco. *Canada:* Humbe River, near Toronto; Lake Winnipeg, Saskatchewan and Red Rivers. I have found them in the watercourses of northern Maine, and St. John's River, in New Brunswick. Dr. Hagen's monograph was published ten years ago. Many new localities have been recorded since; doubtless they will be found in every State and Territory in the Union. The animals may be found sheltered under or between loose stones along the edges of brooks and rivers. They are very active in their efforts to escape. Owing to their greenish and brownish hues, it is difficult to find them. They may easily be kept in confinement for a long time, and their movements and habits studied.—Edward S. Morse.

The Winter in Europe.—The earlier part of the winter of 1879–'80, while it was exceptionally mild in America, was distinguished in Europe for its severity. In France it is spoken of as the coldest winter which has been recorded for more than a century. It appears that the temperature of October was a little below the usual mean. November gave twelve days of frost; and December surpassed everything that had been known in Paris, in the intensity and duration of the cold. From the 26th of November to the 28th of December, that is, during thirty-three consecutive days, there was frost every day, and during fourteen days of the period, from the 14th to the 28th of December, the thermometer did not rise above the freezing-point. The beginning of December was tempestuous. The storm-center, coming up from the ocean on the morning of the 3d, passed Paris between the 4th and 5th, accompanied by a rapid depression of the barometer and a perceptible rise of temperature from about 18°. The storm, having caused great damage in France, then went to the east, and gradually diminished in intensity as it passed over Germany. About ten inches of snow fell during this storm, and four inches more on the 8th, after which it cleared off, and the extraordinary cold began. The mean temperature of December in Paris is 38¼°; the temperature of December, 1879, was 18·3.° The lowest mean temperatures previously recorded in the present century were in 1812 (30·2°), 1829 (25·7°), and 1840 (27.9°). The nearest approach to the temperature of the last December was probably in December, 1788, but the uncertainty of the observations taken at that period makes an exact comparison impracticable. The temperature on the 10th (−14°) was the lowest ever observed. The cold, at the period of its greatest intensity, on the 9th and 10th, presented a remarkable distribution over the surface of Europe. On the first day, two centers of cold were manifested, one being toward Poland, where the thermometer sunk to −32°, the other in the French departments east of Paris. On the second day, the former center had increased in surface but diminished in intensity, while the second center had extended and had reached Paris, and the cold had increased over nearly the whole of France. The temperature continued high on the borders of the British Channel and the ocean, so that great contrasts were presented in places not very far from each other according as they were near to or removed from the sea. Vegetation suffered from the duration of the cold, so that most of the exotics in the public gardens were killed or greatly injured. A zone of high pressure was established in all the west of Europe after the storm of the beginning of the month, the center of which oscillated from France to Poland and from Austria to Denmark. It was observed that the low temperature was special to the inferior regions of the atmosphere. At the height of a little over a thousand yards the air was much more mild. During the latter part of the month the thermometer on the Puy-de-Dôme was often thirty to forty degrees higher than at Clermont, and on the Pic du Midi it rose every day after the 19th to above the freezing-point, while it was still always below it at Paris. The cold terminated suddenly on the 28th, with a storm from the North Sea; a thaw followed, with destructive floods. A new cold term set in after the 4th of January, with a region of high pressure in the center of Europe. The summits again showed a higher temperature than the base of the mountains. The region of extreme cold was this time, however, in Russia.

M. Marié Davy, Director of the Observatory of Montsouris, remarks, in a communication to the Société Française d'Hygiène, that this has been the sixth severe winter of the century; and the six have recurred with remarkable regularity in periods of two each, viz.: 1788–'89 and 1794–'95, interval six years; 1829–'30 and 1837–'38, interval eight years; 1871–'72 and 1879–'80, interval eight years. These periods were each removed to a medium distance of about forty-two years from each other. The near equality of the periods of recurrence is probably a simple coincidence, but it is nevertheless curious. M. Faye has published an account of the meteorological observations, which have been made to the month of May, 1879, at the observatory of the French missionaries in China, at Zi-ka-wei. From them the director of the observatory draws the conclusions — 1. That storms and tempests, and in general all barometric depressions, are propagated in

China and Japan in the same course as the storms and tempests of the Atlantic which reach Europe; 2. That such storms are independent of the prevailing monsoon, and reciprocally, neither interfering with the other. Thus, says M. Faye, in regions opposed to ours in the northern hemisphere, the storms which we call cyclones or typhoons follow identically the same course, whatever may be the distribution of water and land, whether there are currents of warm water like the Gulf Stream, chains of mountains or not, on their way, whatever may be the direction of the lower winds prevailing in the country. The origin of these gyratory phenomena is, then, in the upper region of the atmosphere, whence, away above all the superficial accidents of the globe, they descend to the ground through the lower strata.

Wild Silks.—That our resources for the production of silk are capable of great enlargement is shown by the fact that heretofore only a few of the numerous insects which form silk and only a small number of the plants on which they feed have been utilized, leaving the greater number of insects and plants still unemployed. The known silk-spinners belong to the two families *Bombycidæ* and *Saturniidæ*, of the Lepidoptera. All of the *Saturniidæ* are silk-spinners, but not all of the *Bombycidæ*. Of the *Saturniidæ*, the British Museum catalogue contains the names of two hundred and ninety-four species, and one hundred more species have been added since the catalogue was published. Mr. Thomas Wardle, in a lecture on the wild silks of India, before the Society of Arts, gave a list of fifty-seven silkworms indigenous to India, of which six mulberry-feeding sorts are domesticated, and the others are wild. Besides the mulberry-feeding worms, of which there are also nine wild species, the cocoons of fourteen wild species are utilized. Of these, the principal species are the *Attacus ricini*, the *Attacus cynthia*, or Eria-worm, the *Antheræa Assama*, or Muga-worm, and the *Antheræa paphia*, or Tusser-worm. The *Attacus ricini* is a native of Assam, and feeds on the castor-oil plant and several other plants of the country. The cocoons can not be reeled, but the fiber is exceedingly well adapted for spinning, can be dyed and printed easily and satisfactorily, and forms a cloth of "incredible durability, the life of one person being seldom sufficient to wear out a garment made of it, so that the same piece descends from mother to daughter." *Attacus cynthia* feeds on the ailantus, and has been successfully domesticated in France and England, where "ailanticulture" has a recognized place in industrial economy. Its silk is not adapted for reeling, but spins well, and there is no doubt, says Mr. Wardle, "that a great future remains for this silk, now that spinning-machinery has been so perfected." The *Attacus Atlas* is almost omnivorous, yields a "decidedly good" silk, and has been recommended for introduction into France. The *Antheræa Assama* yields the Muga silk, which forms one of the chief exports of Assam. Five thousand acres are planted in Assam and some Tipperah villages with food for the worm, and are capable of yielding 123,000 pounds of the fiber. Mr. Wardle reports of the silk that it bleaches well, and takes the dye freely, better than Tusser. The *Antheræa paphia*, from which the Tusser silk is derived, is the most widely distributed as well as the most important of the wild-silk producers of India, and has been utilized for many centuries. It feeds on a variety of plants, among them the castor-oil plant, and begins to spin its cocoons in six weeks from the time it is hatched. The silk is woven and used in the provinces of India in mixed fabrics of cotton woof and Tusser weft, but seems also to be used pure in many cloths. The fiber of this silk is flat, thereby showing a strong difference from that of the mulberry silk, which is round, and to this is ascribed its glassy look. So far from this property being a drawback, the luster seems to be enhanced by it after the fiber has become modified and its flatness has been diffused in the loom. The chief obstacle to the general introduction of this silk is the difficulty with which it is made to take colors. A process has been invented to overcome this by applying oxygen to the natural fawn-colored coloring matter of the fiber, but it is too expensive for general use. Mr. Wardle has found a partial solution of the difficulty in a more thorough cleansing of the native product and better reeling, and has made the silk submit to the dye and to the printing process in a tolerably sat-

isfactory manner. In the undyed state it is the most lustrous of all silks, and is very strong. Some of the prints obtained by Mr. Wardle are beautifully suited to wall-hangings, curtains, coverlets, and all kinds of furniture-work; and, while the material has not quite the brilliancy of the mulberry silk in its printed state, it has a richer and softer surface than those of cretonnes or challis, while its lasting qualities are superior to those of any other material. It is beginning to be largely used in France for fabrics and trimmings in which extreme fineness is not required.

Fertilization of the Algerian Sahara.—Some remarkable transformations in the character of the Algerian Sahara have been effected by irrigation. Under its operation a soil has been constituted, in which the intertropical plants grow with great vigor. A cultivator at Ouargla received several medals at the Parisian Exposition for plants which he had raised on a soil thus prepared. The stories that have been told of the productiveness of the Sahara tax the imagination. Fertility is not limited to any one point. It is exhibited wherever water has been brought to the surface of the soil. Most of the Saharan valleys and the beds of the subterranean streams have water in abundance, and only a small effort is needed to bring it to the surface. Sahara is not all a desert, but contains many considerable tracts which are already fit for cultivation. The success which has attended the efforts so far made to introduce tillage renders it nearly certain that a like reward may be gained from similar applications of labor in other parts. Henceforth it will be safe to say that the transformation of the Sahara is only a question of time, labor, artesian wells, means of communication, and security.

The Source of Marsh-Odors.—M. T. L. Phipson recently read, in the French Academy of Sciences, an account of the substances which he had succeeded in extracting from fresh-water algæ. They are palmelline, xanthophyll, chlorophyll, and characine. The last substance receives its name from the odor of *chara*, a well-defined marshy smell which it gives out. It is lighter than water, on the surface of which it forms minute pellicles, but is very sparingly dissolved. It is obtained by first drying the algæ in the air, and then covering them again with cold water as in the preparation of palmelline. After eight or ten hours, a thin iridescent layer will appear on the surface of the water. This is the odorous substance in question. The liquid should be decanted into a long, narrow tube, and shaken with a quantity of ether. The ether dissolves the characine, and leaves it after evaporation in the form of a white, greasy, volatile substance, not saponifiable, soluble in alcohol and ether, hardly soluble in water, and having a strong characteristic odor of the marsh, which it communicates to the water. After some days it evaporates from the surface of the water, or disappears by oxidation, and the water loses its marshy odor. This odor, so strongly developed in plants of the genus *Chara*, is due to this new substance, which is formed by the plant itself during its life, and is not a product of decomposition. Characine is found in all the terrestrial algæ, and in the confervæ.

A Fossil Ferment.—M. Van Tieghem has called attention, in the French Academy of Sciences, to the evidence of the existence of the butyric ferment, *bacilus amylobacter*, in the coal period, which has been obtained by the microscopic examination of the radicles of conifers that have undergone its action, and are silicified in the phytogenic rocks of Saône-et-Loire. These fossils have been subjected to much study by M. B. Renault, assistant naturalist of the museum. The radicles exhibit precisely the same characteristic marks of alteration as are seen in corresponding radicles of the present epoch, which have been kept under water, and have become the prey of the bacilus. We know that the effect in the latter case is to subject the cellulose of the radicles to the butyric fermentation; and the conclusion is legitimate that the reactions developed in the marshes at the expense of the ligneous matter during the coal period were identical with those from which we observe the same effects now. The importance of these observations will be appreciated by those who are studying the part which causes that are now in operation have played in the geological past.

Managing Horses by Electricity.—An ingenious and efficacious method of subduing savage or restive horses has been brought to the notice of the French Société d'Encouragement by M. Bella, administrator of the Omnibus Company of Paris. It is the invention of M. Defoy, who has illustrated its use by some remarkable exhibitions. The machinery is simple, and consists, as shown in the accompanying figure, of a Clark's magneto-electric apparatus inclosed in a box, which is placed within easy reach

of the driver or rider. A conducting wire running through the reins connects the apparatus with the bit. By turning a handle attached to the electro-magnet, a current is formed which affects the horse's mouth, and so surprises him that he stops and stands still. The most dangerous horse may be subdued in a short time by the application of the electric current, combined with a soothing manner and caresses. M. Bella

has described experiments which M. Defoy tried with his apparatus upon some vicious and dangerous horses at the stables of the Omnibus Company. An Hungarian horse, which was considered unsafe to shoe, was brought up to the forge, making evident manifestations of his perversity. In a few minutes after the current was applied to him he allowed himself to be caressed on the shoulders and back, then let his legs be touched and his hind-feet raised; and, finally, suffered the workmen to change his shoes without being restrained or showing any further opposition to the proceedings. A trial of the apparatus was also made in the presence of the director of the Cab Company of Paris upon some horses which it had till then been impossible to shoe. They all yielded to its influence. One of them was accustomed to roll on the ground, strike out, and resist in every possible way. On the first application of the currents, says the director in his report, "To my astonishment they lifted his feet without any great difficulty; at the second, he was as easy to shoe as if he had never opposed the least resistance. The animal was conquered." M. Defoy exhibited before the editor of "La Nature" a dangerous horse, which he arrested instantly after it had sprung into a gallop, by turning the handle of the magneto-electric apparatus. The result is not obtained by any violent or painful action. The current is not strong enough to stupefy the animal; it rather produces in him astonishment, and a disagreeable but not painful sensation of an electrical pricking. The editor of "La Nature" has received the current from the apparatus without experiencing inconvenience. There is nothing in the process to recall the barbarous methods formerly used to subdue animals by force or violence, which hurt them in body and temper. M. Defoy has also invented an electrical stick or switch, which is not less ingenious than his bit. It is a riding-whip containing two conducting wires, which are insulated by leather. The wires terminate in two points set perpendicularly to the whip, and are put in connection, as in the case of the bit, by means of a magneto-electric apparatus. If the horse is in the habit of rearing, it is enough to jog him with the legs as he is preparing to rise, and at the same time apply the points of the electric stick to the top of his shoulders. He will immediately subside and let his head down. So, when a horse tries to turn around, the application of the current to that side of his face toward which he is about to turn will cause him to stop immediately. With the help of this little instrument M. Defoy is able in a little while to make a horse obey all his wishes.

Automatism in Portrait-painting. — Dr. Gaetan Delaunay, in a recent article on this subject, writes that he has often observed that a designer making an extemporaneous sketch of a head involuntarily reproduces his own portrait; and that, having made a scientific study of the fact, he has reached conclusions which are curious, though they are not fully demonstrated. He has been informed by teachers of drawing, painters, and designers, of whom he has made inquiries, that a person tracing with a pencil figures of spontaneous conception will always produce the same head unless he is copying from or imitating a model. M. Luys, professor in the Medical Faculty at Paris, states substantially the same principle in his work on the brain, and explains it by a theory of automatism, or habit. It is illustrated in the works of the French caricaturists. A degree of resemblance may be traced between the design and the designer, whether we consider the work as a whole or in its parts. English painters, endeavoring to represent Frenchmen, give them English characteristics, and French painters invest their figures of foreigners with a French air. So painters of every country impart some of their own national features to their pictures of foreign life, to such a degree that we can generally recognize the nationality of the artist from them. We can not explain the fact better than by supposing that all painters are subject to an irresistible tendency to reproduce their own ethnographic type. Sex exercises a similar influence; little girls amusing themselves at drawing will generally be found making female figures, little boys male figures. Dr. Delaunay has also observed that an artist seeking to represent a woman would always draw the same woman, and has learned from designers that the woman who thus persistently came from their pencil was, of the type which they preferred to all others, the one who figured in their dreams. Rubens is quoted as say-

ing, "I paint women as I love them." Further, artists appear to embody their constitutional features in their figures, and will design large or small subjects according as they are themselves large or small. The figures of portly and vigorous artists will be distinguished by fullness of muscular development. According to this theory, the resemblance extends even to the different parts of the body. Raphael, who preferred to paint Virgins, had a virginal head; Michael Angelo, who had a virile head, put more virility into his creations. If we should go into the room where a deliberative body had sat, and gather up the figures which the members had amused themselves with composing during the tedium of discussion, we would be surprised by observing that each one had sketched something very like his own likeness. Dr. Delaunay has experimented with artists, and with persons who did not know how to draw, and has always found that they made their own profiles in their off-hand sketches. The sketch of an unpracticed person would of course be rude and ungraceful, and an unfair portrait, but there would be traits of resemblance about it sufficient to reveal the author. A friend who had what is called a square head drew a figure which was imperfect enough, but the line defining the back part of the head made a right angle. A person with curled hair is not apt to draw straight hair, but curled; one with straight hair will give his figures hair like his own; a bearded man will give them a full beard, a beardless man none; and peculiarities in the form of the beard are often found reproduced in the drawings. Finally, in the works of imagination of painters and sculptors we may recognize the productions of artists who have all the time multiplied their likenesses in their figures. The same conclusion is applicable to imitative designs. If we have a drawing-class of fifty pupils, having a respectable degree of skill, all drawing at the same head, theoretically we should have fifty heads more or less well executed, but all resembling the model, and consequently one another. This will not, however, be the case. The drawings will differ from each other so obviously that, instead of fifty copies of the same head, there will be fifty different heads. Each pupil executes a different head from the one drawn by his neighbor, and more or less resembling his own head. In proof of this, a letter is quoted from a professor of drawing in a lyceum in Paris, who says: "When our pupils are competing for a prize, they have the same model in view, but each one in copying from it reproduces himself more or less. We may, by simply examining his design, determine whether his face is round, oval, or square, whether it has projecting forms, or a smooth contour with few inequalities." The same is the case with sculptors, and even with costumers, who were found by Dr. Delaunay to be most apt to have figures of their own style in view in fitting their customers.

Echoes in Buildings.—Cords stretched in a kind of network near the ceiling have been recommended for destroying echoes in churches and public halls, and have been tried satisfactorily in St. Peter's Church, Geneva, and in the Assembly Hall of the city offices of Bordeaux, France. When metallic wires are used in the same manner, the resonance is greatly diminished, and is sometimes converted into a musical sound. A remarkable resonance has been noticed in connection with the great staircase of stone in the Walhalla at Regensburg, Germany. The visitor, after going up the first stairs, steps upon a landing from which two other staircases rise in opposite directions. At this point every step calls out a metallic ringing, as if the whole stairs were made of brass. A stamp of the foot on the middle of the landing is answered by a clear, resounding, musical tone. The ringing continues as the visitor goes up the stairs, growing weaker as he approaches the second landing, and finally ceases. The phenomenon is believed to be due to the rapid reflections of the sound-waves between the opposite staircases.

Stammering of the Vocal Cords.—Under this title Dr. Prosser James, of London, describes in the "Lancet" a throat malady, which he says may at times entirely suspend the work of clergymen, lawyers, singers, and others who make professional use of the voice. The disease appears to be due to defective coördination of certain muscles of the larynx, in consequence of which the vocal apparatus fails at intervals to fully

obey the will; the failure giving rise to sudden interruptions of the voice, while the articulating power may remain unaffected. As in other impediments of speech the harmonious action of the muscles engaged in articulation may be disturbed, in this case the disordered coördination affects the voice only. The movements required for articulating syllables are perfectly performed, but the production of vocal sound is at intervals suspended. The affection may cause the patient to stop speaking, as he is conscious of what he sometimes calls a "catch in the breath"; or he may continue a sentence from which some words will be lost to the listener. Isolated sounds are usually correctly articulated, even by confirmed stammerers; and the same is true in these vocal impediments; but it is in the rapid emission of certain combinations of sounds that the sudden arrest is liable to occur. Dr. James states that after long and patient observation of the action of the vocal cords, aided by appliances specially devised for the purpose, he was able to obtain ocular demonstration of the presence of the affection; and, once distinguished from other impediments of speech, he found it amenable to treatment.

Stature of the Japanese.—Mrs. Chaplin Ayrton, M. D., has recently published the results of nearly three hundred observations of the height and span of the Japanese. She found the average height to be five feet three inches, and the span four feet eleven inches. In the case of twenty-four women, taken at random, the tallest was a trifle over five feet two inches, and the average was four feet eight inches, with an average span of four feet six inches. The shortness of the span as compared with the height is a general characteristic that is especially marked in the case of the women. Sixty per cent. of the persons measured had the span less than the height, and thirty-three per cent. greater than the height, while in only 6·8 per cent. were the height and span equal. Climate can hardly be made to account satisfactorily for the smallness of the Japanese, for they live in a temperate region, though it is subject to sudden and marked changes. The general use of charcoal-braziers for heating may have something to do with it, by causing them to inhale the carbonic oxides. The characteristic of their food is the rarity of meat and the abundance of salt. Many of the additional causes of the smallness of the Japanese may be so remote as to cease to affect the nation except by hereditary influence.

Aids to Hearing: the Osteophone.—The audiphone and dentaphone, which have been extensively advertised as instruments for aiding the hearing of the deaf, have been objected to on account of mechanical difficulties in using them. The audiphone to a certain extent obscures the features of the person using it—the dentaphone is held more or less in the line of vision; and both instruments require the constant service of the hands when in use. Dr. Charles H. Thomas, of Philadelphia, has devised an instrument that is intended to obviate these difficulties, which he has named the osteophone. It consists of a large receiving diaphragm attached in an arched form to a rod of wood or metal, which rod is bent in the form of a pipe-stem. One end of the rod is to be held firmly between the teeth as a pipe is held, leaving the hands of the listener free for other occupations, while he is able to hear all the sounds that may be conveyed by the diaphragm. The diaphragm is below and away from the face, and comparatively inconspicuous. The inventor suggests that ornamental fans, coated with shellac and tipped with ivory or hard rubber, may be made to answer fairly well for occasional use, but will be unsatisfactory if depended on permanently. Fuller's cardboard, treated with shellac varnish, and dried, makes one of the best of resounding mediums. A piece of yellow pine turned into a trumpet-shape, and placed in the mouth of the deaf person, will convey a good volume of sound, and even a string connecting the upper teeth of the persons conversing perceptibly aids the sound. A small rod of hard wood, connecting the teeth of the two persons, gives a volume of sound many times exceeding that transmitted either by the audiphone or the dentaphone. Sensible vibrations, produced by and corresponding to those of the voice, are propagated in the hard palate and base of the skull of persons speaking in the ordinary tones; and the rod

which has just been mentioned will convey the voice distinctly when placed against the skull of the hearer, and will even, according to Dr. Thomas, convey audible speech from the skull of one to that of the other. The efforts to make the audiphone and dentaphone useful as regular instruments of hearing to the deaf have not had satisfactory results. Dr. Thomas acknowledges that the expectations which have been excited on the subject are likely to be disappointed. Those who are able to hear with the aid of the audiphone hear their own voices perfectly without it; while those who are unable to hear their own voices without it can hear nothing with it. Dr. Charles S. Turnbull, of Philadelphia, states in the "Medical and Surgical Reporter" that his experience with these instruments has been as nothing, because the suitable cases were so few and far between. The cases in which they have proved of benefit are cases of acoustic deafness, generally due to middle-ear disease, for which devices of the nature of the ear-trumpet generally afford a more satisfactory remedy than either of the instruments under consideration.

Deterioration of Bookbinding by Illuminating Gas.—Professor William Ripley Nichols publishes an interesting paper on the deterioration of the binding of books in libraries, which is commonly ascribed to the action of sulphuric acid supposed to be generated by burning coal-gas. The agency of sulphuric acid having been disputed by Dr. Wolcott Gibbs and others, Professor Nichols made investigations to determine the question. Having examined a large number of samples of leather in every stage of decay, he found that morocco was but little affected, common sheep binding was attacked, and Russia leather and calf were badly acted upon. An acid taste and an acid reaction were observed that were more marked in proportion as the leather was decayed, and sulphuric acid was found in the extract made from the leather with water, in a similarly increasing proportion. Ammonia was also present, in about such a proportion as in combination with the sulphur would constitute the acid sulphate of ammonia. Samples of fresh leather gave extracts only slightly acid, not enough so to affect the taste, and contained only a minute amount of sulphuric acid in combination. Samples of Russia leather and sheep of good quality yielded from less than a quarter to less than a half of one per cent. of acid, and less than quarter of one per cent. of ammonia. A sample of well-worn but not decayed sheep taken from a Bible more than sixty years old, which had never been exposed to gas, gave 1·42 per cent. of sulphuric acid. Other samples, of very rotten Russia, and of scrapings from a number of books, gave from eight to ten per cent. of sulphuric acid, combined with ammonia. A quantity of rotten leather was carefully extracted with water, and crystals of sulphate of ammonia were obtained from it. It is difficult, in the face of these facts, Professor Nichols urges, to escape the conviction that bindings of Russia, calf, or sheep absorb sulphuric acid when exposed to the products of the combustion of illuminating gas. No other condition to which books are commonly exposed can so well account for the large proportion of acid which was found in the old bindings. It has been objected to this view that sulphurous (not sulphuric) acid is the general product of the combustion of sulphur compounds; but Professor Nichols's analyses of the results of the burning of gas have brought out sulphates with no evidence of the presence of a sulphite. It is admitted to be possible that the disintegration of the leather precedes the absorption of sulphuric acid, and prepares the way for it; and Professor Nichols intends to make experiments for the determination of this question.

NOTES.

We ask the attention of our readers to the premiums offered to new subscribers for "The Popular Science Monthly." No such valuable list of modern scientific works has ever before been prepared for such a purpose; and no other publishing-house in this country or in the world is able to furnish from its own stock such a varied and admirable popular scientific library as that which D. Appleton & Company now present for the choice of those who will become subscribers to this periodical. It is important that its patronage and influence should be increased.

We want the means of improving it. There are thousands of intelligent people who have not yet made its acquaintance; and to reach them we must rely upon the help of our friends, who know what the "Monthly" is worth. We ask each one of our present subscribers to detach the list of premiums from his number, and present it to some reading neighbor who can appreciate and ought to have "The Popular Science Monthly." There can be no better investment of money for individual improvement and sound family education than this. The magazine is worth twice what it costs to any thoughtful man, and when he can get his choice among a hundred sterling books as an extra inducement, which virtually reduces the cost of the "Monthly" to three dollars, he ought certainly to be informed of his advantage.

Dr. Phipson has proposed a new method of solving the question of a cheap household light. He has succeeded, with a comparatively feeble electric current, in perceptibly increasing the phosphorescence of certain bodies which are made faintly light by the rays of the sun. He incloses in a Geissler tube, containing a gas in a more or less rarefied condition, a phosphorescent body, the sulphuret of barium, for instance. By causing a constant current of a certain intensity to pass through the tube, he obtains a uniform and an agreeable light, at an expense which he estimates to be less than that of gaslight.

Dr. Carpenter says the entire absence of sunlight on the deep-sea bottom seems to have the same effect as the darkness of caves, in reducing to a rudimentary condition the eyes of such of their inhabitants as fish and crustacea which ordinarily enjoy visual power; and many of these are provided with enormously long and delicate feelers or hairs, with which they feel their way about, just as a blind man does with his stick.

The use of camomile-flowers for the adulteration of smoking-tobacco has recently been discovered in England, just in time to stop an enormous swindle. The flowers are first deprived of their bitter principle by exhaustion in water, and then colored, sweetened, and dried, when they are ready for mixing with cut tobacco. A preparation sold under the name of "The New Smoking Mixture" was found on examination to be about one third tobacco and two thirds camomile-flowers.

Chintamanay Ragoonatha Charry, F. R. A. S., for thirty-five years connected with the Madras Observatory, and for the last seventeen years its head assistant, died on February 3, 1880. Besides a large amount of valuable work, the record of which is confined to the observatory, he contributed several papers to the Royal Astronomical Society of London, and was made a Fellow of that body in January, 1872. He was the first and only native of India who, up to the time of his death, had entered the lists as a discoverer of new celestial objects, having detected two new variable stars—R. Reticuli in 1877, and V. Cephei in 1878. During the later years of his life he delivered popular lectures on astronomy, explaining the principles of the science in simple and familiar terms, with a view to the removal of some of the absurd notions and ignorant superstitions concerning celestial phenomena that are propagated by the Hindoo astrologers.

The first volume of "Studies from the Biological Laboratory of the Johns Hopkins University" is announced. It is made up of original papers on physiology, animal and vegetable morphology, and embryology, contributed by members of the university, and based on investigations conducted in the biological laboratory and marine zoölogical station of the institution. The present volume contains 519 pages, with forty plates and illustrations in the text. Price, $3.50. A volume a year, issued in quarterly parts of about 100 pages, at a dollar each, is contemplated; or it can be obtained at the end of the year, bound complete, for $5. As they are doing some of the best original work in the country at Johns Hopkins, in these departments, those who wish to keep posted in the latest results of biological inquiry will do well to procure these publications as they appear.

Died, March 11th, at Bethlehem, Pennsylvania, Professor William T. Roepper, aged seventy years. Professor Roepper was born in Germany, came to America forty years ago, and in 1866 was appointed to the chair of Mineralogy and Geology in Lehigh University. He gave chief attention to the science of mineralogy, the mathematical relations of crystals and the chemical composition of minerals being subjects of special study. The practical aspects of the science were also of much interest to him, and his services as an expert were often in request.

M. G. Carlet, of France, has been studying the locomotion of insects and arachnids, and reports as the result of his observations that the walking of insects may be represented by that of three men in Indian file, the foremost and hindmost of whom keep step with each other, while the middle one walks in the alternate step. The walking of arachnids is represented by four men in file, the even-numbered ones walking in one step, while the odd-numbered ones walk in the alternate step.

OTTO WILHELM STRUVE.

UNIV. OF MICH.